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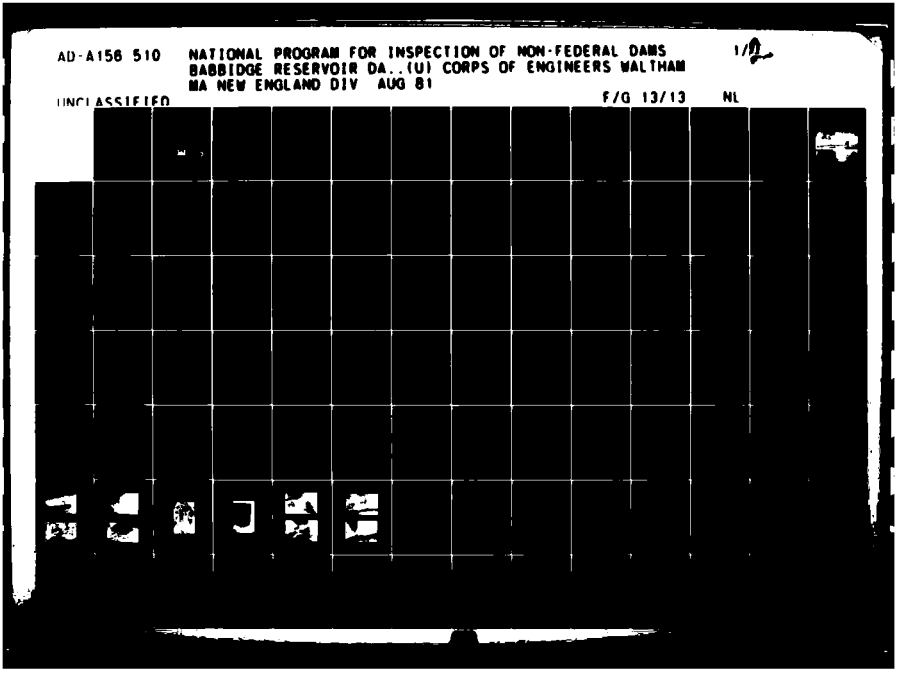
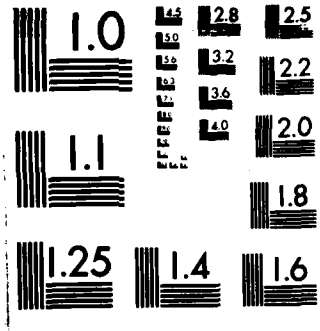




CONNECTICUT RIVER BASIN

ROXBURY, NEW HAMPSHIRE

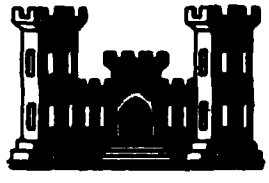
BABBIDGE RESERVOIR DAM

NH 00398

NHWRB 206.03

PHASE I INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM



DEPARTMENT OF THE ARMY

NEW ENGLAND DIVISION, CORPS OF ENGINEERS

WALTHAM, MASS. 02154

AUGUST 1981

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

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7. AUTHOR(s) U.S. ARMY CORPS OF ENGINEERS NEW ENGLAND DIVISION		8. CONTRACT OR GRANT NUMBER(s)
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Cover program reads: Phase I Inspection Report, National Dam Inspection Program; however, the official title of the program is: National Program for Inspection of Non-Federal Dams; use cover date for date of report.

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

DAMS, INSPECTION, DAM SAFETY,
Connecticut River Basin,
Roxbury, New Hampshire,
Roaring Brook

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The dam is a 38 ft. high earth embankment with a reinforced concrete corewall. It is small in size with a high hazard potential. Significant economic loss and possible loss of more than a few lives could result from the event of a dam failure. With stoplogs, the spillway is capable of passing 9% of the test flood.The dam is in fair condition. Remedial measures should be undertaken by the owner.

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DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
424 TRAPELO ROAD
WALTHAM, MASSACHUSETTS 02254

REPLY TO
ATTENTION OF:
NEDED-E

AUG 3 1 1981

Honorable Hugh J. Gallen
Governor of the State of New Hampshire
State House
Concord, NH 03301

Dear Governor Gallen:

Inclosed is a copy of the Babbidge Reservoir Dam (NH-00398) Phase I Inspection Report, prepared under the National Program for Inspection of Non-Federal Dams. The report is based upon a visual inspection, a review of past performance, and a preliminary hydrological analysis.

The preliminary hydrologic analysis indicated that the spillway capacity would likely be exceeded by floods greater than five percent of the Probable Maximum Flood (PMF). Our screening criteria specifies that a dam classified as high hazard with a spillway capacity insufficient to discharge fifty percent of the PMF be judged as having a seriously inadequate spillway. As a result, this dam is assessed as unsafe, non-emergency until more detailed studies prove otherwise or corrective measures are completed.

The term "unsafe" applied to a dam because of an inadequate spillway does not indicate the same degree of emergency as that term would if applied because of structural deficiency. It does indicate, however, that a severe storm may cause overtopping and possible failure of the dam, with significant damage and potential loss of life downstream.

We recommend that within twelve months from the date of this report the owner of the dam engage the services of a qualified registered engineer to determine further the potential of overtopping the dam and the need for and the means to increase project discharge capacity. Based on this determination, appropriate remedial mitigating measures should be designed and completed within 24 months of this date of notification. In the interim a detailed emergency operation plan and warning system should be promptly developed and round-the-clock surveillance should be provided during periods of unusually heavy precipitation or high project discharge.

AUG 3 1 1981

NEDED-E
Honorable Hugh J. Gallen

I approve the report and support the findings and recommendations described in Section 7, with qualifications as noted above. I request that you keep me informed of the actions taken to implement these recommendations since this follow-up is an important part of the program.

Copies of this report have been forwarded to the Water Resources Board and to the owner, State of New Hampshire, Water Resources Board. Copies will be available to the public in thirty days.

I wish to thank you and the Water Resources Board for your cooperation in this program.

Sincerely,

C. E. EDGAR, III
Colonel, Corps of Engineers
Commander and Division Engineer

NATIONAL DAM INSPECTION

PHASE I INSPECTION REPORT

Identification No.:	NH 00398
NHWRB No.:	206.03
Name of Dam:	Babbidge Reservoir Dam (Roaring Brook Dam)
Town:	Roxbury
County and State:	Cheshire, New Hampshire
Stream:	Roaring Brook
Date of Inspection:	May 13, 1981

BRIEF ASSESSMENT

The Babbidge Reservoir Dam; also known as Roaring Brook Dam is a 38-foot-high earth embankment with a reinforced concrete corewall. There is a 36-foot-long concrete overflow spillway at the left abutment and a gatehouse at the crest which controls flow from the reservoir and from the Quarry Dam upstream. The overall length of the dam is 255 feet, and its maximum impoundment is 528 acre-feet. The dam was constructed in 1931, to be used for water supply for the City of Keene, New Hampshire. It is presently owned by the City of Keene and is in service.

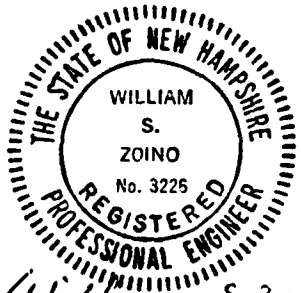
The drainage area for the dam covers approximately 5.5 square miles of rolling to mountainous forest with some storage available in Woodward Pond in the upper reaches of the watershed.

The Babbidge Reservoir Dam is SMALL in size, and its hazard potential classification is HIGH since significant economic loss and possible loss of more than a few lives could result from the event of a dam failure. The appropriate test flood for a dam classified as small with a high hazard potential is between one-half of the Probable Maximum Flood and the Probable Maximum Flood (PMF). One-half of the Probable Maximum Flood has been adopted as the appropriate test flood. The analysis in Appendix D shows the one-half PMF to be 5,500 cfs with the water surface at elevation 980.2 feet (NGVD). This flood would overtop the dam by 3.2 feet. The spillway is capable of passing 29% of the test flood before overtopping with no stoplogs in place. With stoplogs, the spillway is capable of passing 9% of the test flood.

The dam is in FAIR condition at the present time. It is recommended that the owner retain the services of a qualified registered professional engineer to perform a detailed hydraulic and hydrologic investigation to further define the need for and means to increase the project discharge capacity or the ability of the dam to withstand overtopping; to develop a method for removal of the trees and stumps (including the roots) from the embankments, and backfill the resulting voids with suitable compacted material; to uncover and evaluate the condition and location of the downstream end of the outlet conduit; to inspect the spillway under low-flow conditions; and to repair the concrete on the gatehouse, right end wall, and spillway.

Remedial measures to be undertaken by the owner include implementing a program of diligent and periodic maintenance; implementing a program of annual technical inspections of the dam and its appurtenances, including operation of all outlet works and monitoring the seepage areas near the downstream right abutment; developing a plan for surveillance of the dam during flood periods and a formal written system for warning the appropriate officials and the downstream residents in the event of an emergency; and redecking the timber footbridge.

These engineering studies and remedial measures should be implemented by the owner within one year of receipt of this Phase I Inspection Report.



William S. Zoino
NH Registration No. 3226

Nicholas A. Campagna, Jr.
California Registration No. 21006

This Phase I Inspection Report on **Babbidge Reservoir Dam (NH-00398)** has been reviewed by the undersigned Review Board members. In our opinion, the reported findings, conclusions, and recommendations are consistent with the Recommended Guidelines for Safety Inspection of Dams, and with good engineering judgement and practice, and is hereby submitted for approval.

ARAMAST MAHTESIAN, MEMBER
Geotechnical Engineering Branch
Engineering Division

CARNEY M. TERZIAN, MEMBER
Design Branch
Engineering Division

JOSEPH W. FINEGAN, JR., CHAIRMAN
Water Control Branch
Engineering Division

APPROVAL RECOMMENDED:

JOE B. FRYAR
Chief, Engineering Division

PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D.C., 20314. The purpose of a Phase I Investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigations, and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify any need from such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through continued care and inspection can there be any chance that unsafe conditions be detected.

Phase I Inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the Spillway Test Flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. Because of the magnitude and rarity of such a storm event, a finding that a spillway will not pass the test flood should not be interpreted as necessarily posing a highly inadequate condition. The test flood provides a measure of relative spillway capacity and serves as an aide in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

The Phase I Investigation does not include an assessment of the need for fences, gates, no trespassing signs, repairs to existing fences and railings, and other items which may be needed to minimize trespassing and provide greater security for the facility and safety to the public. An evaluation of the project for compliance with OSHA rules and regulations is also excluded.

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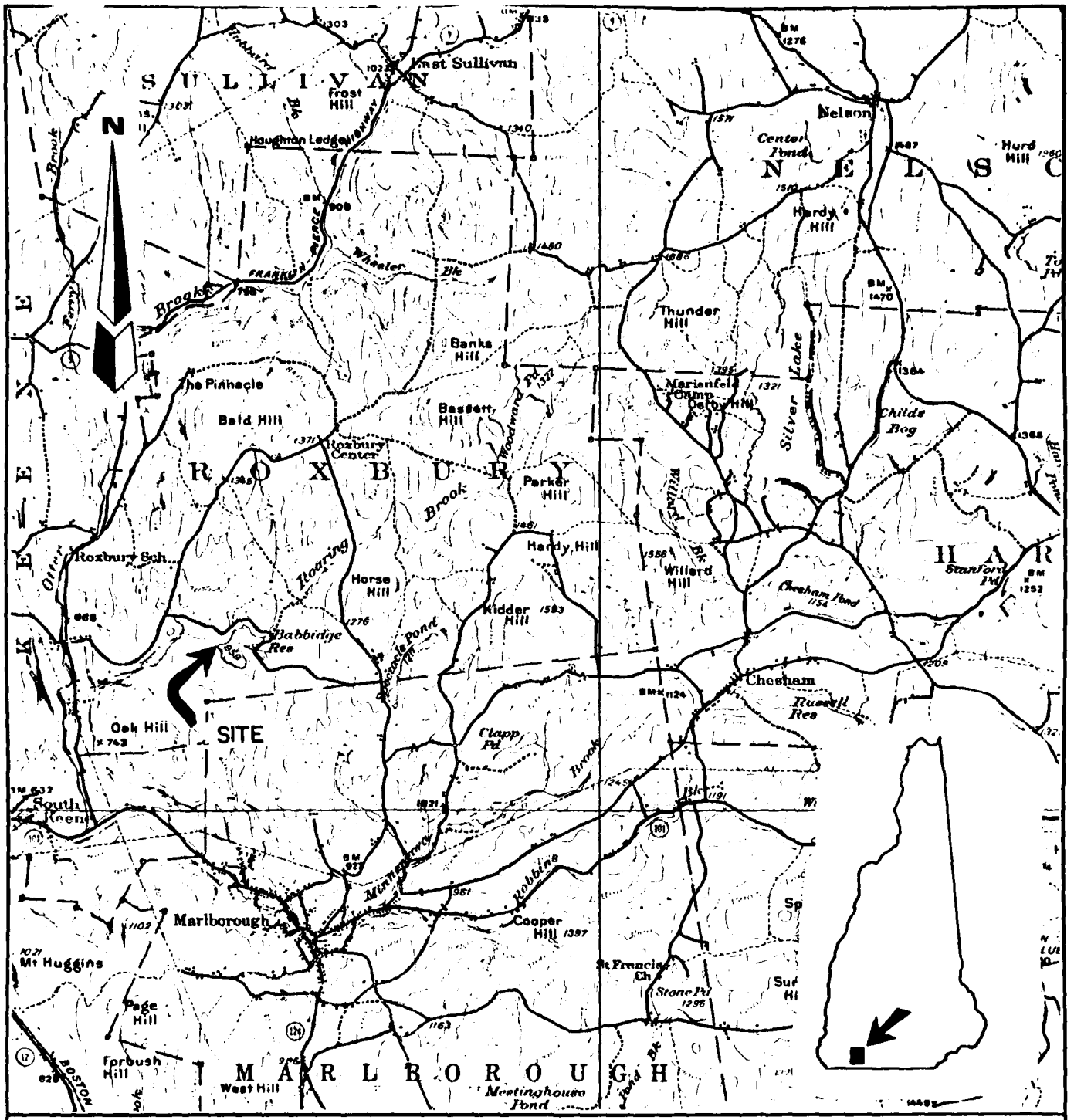
APPENDICES

Overview of Dam



GOLDBERG · ZOINO & ASSOCIATES, INC.
GEOTECHNICAL - GEOHYDROLOGICAL CONSULTANTS
NEWTON UPPER FALLS, MASSACHUSETTS

U.S. ARMY ENGINEER DIV. NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASSACHUSETTS

NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

LOCUS PLAN

FILE No. 2605

BABBIDGE RESERVOIR DAM — KEENE, NEW HAMPSHIRE

SCALE AS NOTED

DATE MAY 1981

National Dam Inspection Program

Phase I Inspection Report

Babbidge Reservoir Dam

Section 1: Project Information

1.1 General

(a) Authority

Public Law 92-367, August 8, 1972, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a National Program of Dam Inspection throughout the United States. The New England Division of the Corps of Engineers has been assigned the responsibility of supervising the inspection of dams within the New England Region. Goldberg-Zoino & Associates, Inc. (GZA) has been retained by the New England Division to inspect and report on selected dams in the State of New Hampshire. Authorization and notice to proceed were issued to GZA under a letter of April 29, 1980, from Colonel William E. Hodgson, Jr., Corps of Engineers. Contract No. DACW 33-80-C-0055 has been assigned by the Corps of Engineers for this work.

(b) Purpose

(1) Perform technical inspection and evaluation of nonfederal dams to identify conditions which threaten the public safety and thus permit correction in a timely manner by nonfederal interests.

(2) Encourage and prepare the states to initiate quickly effective dam safety programs for nonfederal dams.

(3) Update, verify, and complete the National Inventory of Dams.

1.2 Description of Project

(a) Location

The Babbidge Reservior Dam is located on Roaring Brook, approximately 1.3 miles upstream of Roxbury, New Hampshire,

and one mile upstream of the confluence with Otter Brook. It can be reached from town roads which intersect State Route 101 near Keene, New Hampshire. The dam is shown on U.S.G.S. Monadnock, NH Quadrangle at approximate coordinates N42 56.0', W72 13.3' (see Location Map on Page vi). Page B-2 of Appendix B is a site plan for this dam.

(b) Description of Dam and Appurtenances

The Babbidge Reservoir Dam consists of a homogeneous earthfill embankment with a concrete corewall, a concrete overflow spillway at the left abutment, two inlet pipes equipped with trash racks, and two outlet pipes. A gatehouse near the middle of the dam houses four gate stems which route flow through the dam. Intakes include a low-level and a high-level intake at this dam and a pipe from an upstream dam. Outlets route flow to the town water supply system and a 24-inch-diameter outlet conduit which daylights at the downstream toe of the dam. The overall length of the dam is approximately 255 feet.

(1) Embankment

The embankment is constructed of semipervious silt, sand, and gravel. It is 215 feet long and a maximum of 31 feet high. The upstream slope is approximately 2.5 horizontal to 1 vertical, and the downstream slope is approximately 2 horizontal to 1 vertical. The crest width is 12 feet. A concrete corewall extends from the spillway to the right abutment. This wall is keyed into bedrock at the left end and 4 feet to 5 feet into glacial till at the right end. This wall is 2 feet 3 inches thick at the bottom and tapers to 1 foot thick at the top. The top is 2 feet below the crest of the dam.

(2) Concrete Spillway

The spillway is a gravity concrete overflow structure at the left abutment. Its crest is 6 feet below the crest of the dam (elevation 971.0), and it is divided into four bays of 9 feet 3 inches each. Each bay is equipped with stoplogs to elevation 974.4. A walkway extends across the spillway from the dam embankment to the left abutment. There is a reinforced concrete training wall at the right side of the spillway which extends downstream approximately 120 feet.

(3) Appurtenant Structures

There is a brick masonry gatehouse located at the crest of the dam near the middle of the embankment. This structure houses four gate stems which control and route flow from the reservoir and a pipe from the Quarry Dam upstream. Inlet pipes include the 12-inch pipe from the upstream dam, a 20-inch-diameter pipe from the reservoir low-level intake at elevation 947, and a 16-inch-diameter pipe from the reservoir high-level intake at elevation 960. There is a 24-inch-diameter outlet conduit which daylights at the downstream toe of the embankment and a 12-inch-diameter pipe which carries water to the Keene water supply system.

(c) Size Classification

The dam has a maximum impoundment of 528 acre-feet and a height of 38 feet. According to the Corps of Engineers' Recommended Guidelines, a small size dam is one with a maximum storage section between 50 acre-feet and 1,000 acre-feet or a height between 25 feet and 40 feet. Therefore, this dam is classified as SMALL in size, based on both criteria.

(d) Hazard Classification

The hazard potential classification for this dam is HIGH because of the significant economic losses and potential for loss of more than a few lives downstream in the event of dam failure. There are six houses approximately one mile downstream and three houses 1.2 miles downstream which could be affected by the dam failure flood. The prefailure flow conditions would cause no flooding, but the postfailure flow would cause 1 foot to 5 feet of flooding at the first set of houses and 7 feet of flooding at the second.

(e) Ownership

The dam is owned by the City of Keene, New Hampshire. It is overseen by the Department of Public Works, Keene, New Hampshire, 03431.

(f) Operator

The operation of the dam is controlled by the Department of Public Works of Keene, New Hampshire. Mr. Demilio of the DPW can be reached by telephone at (603) 352-6550.

(g) Purpose of Dam

The dam serves as a storage reservoir for the water supply system of the City of Keene, New Hampshire.

(h) Design and Construction History

The dam was constructed in 1931. It was designed by Weston and Sampson Consulting Engineers, 10 High Street, Boston, Massachusetts. It was built by the Public Service Commission, Concord, New Hampshire.

(i) Normal Operating Procedure

No formal operating procedures exist for this dam. The waste gate is normally closed. The water supply gate is normally open.

1.3 Pertinent Data

(a) Drainage Area

The drainage area for this dam covers 5.5 square miles. It is made up primarily of rolling woodland with some storage available in Woodland Pond in the upper reaches of the watershed. Elevations range from 960 to 1686 feet NGVD in this area.

(b) Discharge at Dam Site

(1) Outlet Works

The outlet works at this dam consist of a 24-inch-diameter waste pipe, equipped with a vertical lift slide gate and a 12-inch-diameter water supply pipe, which is also equipped with a gate. Two intake structures are located on the upstream slope. The lower intake

is at elevation 946.4 feet (NGVD), and the upper intake is at elevation 959.3 feet (NGVD). The discharge capacity of the waste outlet with the reservoir at the top-of-dam elevation (977 feet NGVD) is 82 cfs.

(2) Maximum Known Flood

Based on a questionnaire dated October 13, 1938, (Page B-22 of this report) and some calculations based on the dam rating curve, the hurricane of 1938 caused a spillway discharge of approximately 700 cfs at this dam.

(3) Ungated Spillway Capacity at Top of Dam

The capacity of the spillway with the reservoir at top-of-dam elevation (977 feet NGVD) is 1,850 cfs with no stoplogs in place.

(4) Ungated Spillway Capacity at Test Flood

The discharge capacity of the spillway at the test flood elevation (980.2 feet NGVD) is 3,220 cfs with no stoplogs in place.

(5) Gated Spillway Capacity at Normal Pool

There are no gated spillways.

(6) Gated Spillway Capacity at Test Flood

There are no gated spillways.

(7) Total Spillway Capacity at Test Flood

The total discharge over the spillway at the test flood elevation (980.2 feet NGVD) is 3,220 cfs.

(8) Total Project Discharge at Top of Dam

The total project discharge at test flood elevation (980.2 feet NGVD) is 5,500 cfs.

(c) Elevation

(1) Streambed at downstream toe of dam: 939+

(2) Bottom of cutoff: Unknown

(3) Maximum tailwater: Unknown

(4) Normal pool: Approximately 973

(5) Full flood control pool: Not applicable

(6) Spillway crest: 971.0
With stoplogs: 974.4

(7) Design surcharge: Unknown

(8) Top of dam: 977

(9) Test flood surcharge: 980.2

(d) Reservoir (length in feet)

(1) Normal pool: 2,000

(2) Flood control pool: Not applicable

(3) Spillway crest pool: 2,000

(4) Top of dam pool: 2,000

(5) Test flood pool: 2,000

(e) Storage (acre-feet)

(1) Normal pool: 450

(2) Flood control pool: Not applicable

(3) Spillway crest pool: 450

(4) Top of dam pool: 528

(5) Test flood pool: 624

(f) Reservoir Surface (acres)

(1) Normal pool: 30

(2) Flood control pool: Not applicable

(3) Spillway crest pool: 30

(4) Test flood: 30

(5) Top of dam: 30

(g) Dam

(1) Type: Homogeneous earth embankment

(2) Length: 215 feet

(3) Height: 38 feet

(4) Top width: 12 feet

(5) Side slopes:

Upstream: 2.5 horizontal to 1 vertical
Downstream: 2.0 horizontal to 1 vertical

(6) Zoning: Homogeneous

(7) Impervious core: Concrete corewall

(8) Cutoff: Corewall keyed into rock or glacial till

(9) Grout curtain: None

(h) Division and Regulating Tunnel

Not applicable

(i) Spillway

(1) Type: Broad crested channel blasted in rock in the left abutment

(2) Length of weir: 36 feet

(3) Crest elevation: 971 feet NGVD

(4) Gates: None, stoplogs to elevation 974.4 feet NGVD

(5) Upstream channel: Reservoir

(6) Downstream channel: Steep rock channel

(j) Regulating Outlets

The regulating outlet is a system of four gates controlling flows to the water supply pipe and the waste pipe. The 24-inch-diameter waste pipe has an invert elevation of 946.3 feet (NGVD) at the discharge end. It is fed by a 20-inch-diameter vertical lift gate from the lower intake and a 16-inch-diameter vertical lift gate from the upper level intake.

Section 2: Engineering Data

2.1 Design

Some of the original design plans by Weston and Sampson are available, as are the final site plans. Reduced copies of these plans are reproduced in Appendix B of this report. Concrete and soil sample records are available.

2.2 Construction

Photographs taken during construction, concrete test data, and some correspondence are contained in the file maintained by the New Hampshire Water Resources Board.

2.3 Operation

No operational records are available for this dam.

2.4 Evaluation of Data

(a) Availability

There is minimal detailed design and construction data available for evaluation.

(b) Adequacy

The lack of in-depth engineering precludes a definitive review. Therefore, the adequacy of the dam cannot be assessed from the standpoint of reviewing design and construction data. This assessment of the dam is based primarily on the visual inspection, past performance, and sound engineering judgment.

(c) Validity

Since the observations of the inspection team generally confirm the information contained in the records of the New Hampshire Water Resources Board, a satisfactory evaluation for validity is indicated.

Section 3: Visual Inspection

3.1 Findings

(a) General

The Babbidge Reservoir Dam is in fair condition at the present time.

(b) Dam

(1) Embankment (See Photos 1, 3, 4, and 5)

The alignment of the dam along the crest is generally good to slightly irregular. The irregularity consists of a vertical depression near the gatehouse which is visible in Photo No. 1. This depression is due to the manner of construction and is not attributed to movement of the crest. The riprap on the upstream slope is generally in good condition, although there is brush growing through the riprap.

There is heavy brush and tree growth on the lower portion of the downstream slope, and there are stumps remaining from previous clean-up efforts.

Some seepage was noted at two locations (see Page C-2) on the downstream slope. The seepage noted at the downstream toe at the rock fill was on the order of one to two gallons per minute. This seepage was clear although there is some rust-colored staining of the ground in this area. The rockfill is believed to cover the downstream end of the outlet conduit, and the seepage may be the result of the leaking gate. Clear seepage on the order of one-half gallon per minute was noted at the right abutment. These conditions are not significant at present, but the flows should be observed on a regular basis, and any change in the quantity or clarity of the flow should be investigated.

(2) Spillway (See Photos 7 and 8)

The spillway appears to be in good condition, although it was inspected under sheet flow conditions. A thorough inspection of this structure should be made under low flow conditions. There is some surface

erosion up to 4 inches deep on the downstream face. There is some debris caught at the flashboards which should be cleared. The stoplogs are in good condition with the exception of one broken plank. The elevation of the stoplogs in the center bays is slightly higher than the end bays. The wooden footbridge over the spillway is partially deteriorated, and one plank at the right endwall is missing. The steel pipe railing is in good condition.

(3) Right End Wall (See Photos 8, 9, and 10)

The upstream portion of this wall is in good condition, with no evidence of spalls, erosion, or cracking. The downstream portion of the wall has been subjected to erosion up to 4 inches deep at its interface with the rock foundation. At the angle point of the wall, there is an area of concrete erosion 3 feet long, 18 inches high, and 12 inches deep. Reinforcing steel is exposed at this location.

(c) Appurtenant Structures

Gatehouse (See Photos 1, 4, and 6)

Surface erosion 18 inches high, 12 inches wide, and 6 inches deep has occurred at the left upstream corner of the foundation of this structure. The brick bearing walls and the wood framed roof are in good condition. At the time of the inspection, no access was available to the gatehouse, so the interior and gate stems could not be observed. The gates are reported to be operable. The outlet end of the waste pipe could not be observed due to riprap dumped around the pipe. The outlet is apparently buried within the embankment.

(d) Reservoir Area (See Photo 1)

The shore of the reservoir area is generally gently, sloping woodland. It appears to be stable and in good condition.

(e) Downstream Channel (See Photos 2, 8, and 9)

The rock channel slopes steeply down the left abutment to the natural streambed. The channel appears stable and in good condition.

3.2 Evaluation

The dam and its appurtenances are generally in fair condition at the present time. The potential problems observed during the visual inspection are listed below:

(a) Trees and stumps on downstream slope may damage slope due to growth uprooting or rotting of roots, leaving a path for seepage and internal erosion of the dam embankment.

(b) Brush growth on upstream slope may damage slope or riprap.

(c) Debris on spillway decreases the spillway capacity.

(d) Deterioration of footbridge over spillway is a safety hazard.

(e) Deterioration of concrete on gatehouse and right training wall should be repaired.

(f) Rock dumped over the end of the waste pipe decreases the discharge capacity and should be corrected.

Section 4: Operational and Maintenance Procedures

4.1 Operational Procedures

(a) General

No written operational procedures exist for this dam. It is operated as necessary for the water supply of the City of Keene, New Hampshire.

4.2 Maintenance Procedures

Maintenance of the dam is performed on an "as needed" basis by the Department of Public Works of the City of Keene. No formal maintenance program exists for this dam.

4.3 Maintenance of Operating Facilities

No maintenance program exists for the operating facilities of this dam. The gates are not operated regularly.

4.4 Description of Warning System

There is no warning system in effect.

4.5 Evaluation

The dam's present condition is a direct result of the lack of a maintenance program for the dam. Emphasis on routine maintenance will assist the owner in assuring the long-term safety of the dam and operating facilities. A formal, written, downstream emergency warning system should be developed for this dam.

Section 5: Evaluation of Hydraulic/Hydrologic Features

5.1 General

Babbidge Dam is an earthfill structure on Roaring Brook in the town of Roxbury, New Hampshire. The dam is about one mile upstream of the confluence of Roaring Brook and Otter Brook, which is downstream of the Otter Brook Reservoir. The dam was built in 1931 and still functions as a water supply reservoir. The 5.5-square-mile drainage area is rolling and forested, with some storage available from Woodward Pond located in the upper reaches of the watershed.

The dam has a 215-foot-long crest with a concrete core wall, and a 36-foot stoplog section. The overall length of the dam is about 255 feet. The stoplog section consists of four bays that are at elevation 974.4 feet (NGVD). The crest of the remainder of the dam is at 977 feet, which is about 38 feet higher than the downstream channel. The downstream face of the dam is an earth-filled slope which is grassed and wooded.

Downstream of the dam, the gradient of Roaring Brook sharply increases, and the overbanks are steep and thickly covered. Another dam and a small pond are located approximately 4,000 feet downstream of Babbidge Dam. The pond appears to have been a holding pond for water supply, but it is now abandoned. While the dam is about 75 feet long and 20 feet high, the ponding area occupies less than one acre, with very little storage capacity. This impoundment would not significantly attentuate a dam break flood, nor would it represent a hazard area impacted by the break.

About a mile downstream of Babbidge Reservoir, Roaring Brook passes through a 16-foot-wide by 6-foot-high box culvert with a low chord 2 feet below the roadway. Two houses upstream of this crossing are, respectively, 5 feet and 3 feet above the road elevation. On the downstream side are four houses which are all within about one foot of the road elevation.

Just downstream of this crossing, Roaring Brook joins Otter Brook. About 500 feet downstream of this confluence are three houses, all about 6 feet above the Otter Brook streambed. Otter Brook has a much wider stream cross section than Roaring Brook, and the stream gradient flattens out. Just over a mile downstream of the confluence, Minnewawa Brook joins Otter Brook and the channel widens to about 30 to 40 feet.

5.2 Design Data

Babbidge Dam (originally called Roaring Brook Dam) was built in 1931 and used as a water supply reservoir. Some of the original design plans by Weston and Sampson are available, as are the final plans for the site. These are shown on Pages B-3 through B-9 of this report.

5.3 Experience Data

A questionnaire dated October 13, 1938, indicates that the 1938 hurricane flood on Roaring Brook brought the pond stage to about 3.5 feet above the permanent crest of the spillway and that two stoplogs were washed out. From this information and the dam rating curve, if the permanent crest of the spillway is taken to be the present crest of the stoplog section at 974.4 feet, then a flood of about 700 cfs would have occurred. This is reasonable for the 5.5 square mile drainage area.

5.4 Test Flood Analysis

The impoundment of less than 1,000 feet and the height of less than 40 feet classify this dam as a SMALL structure. The appropriate hazard classification is HIGH because of the damage expected at several residential houses and the potential for loss of more than a few lives. The Test Flood for a dam classfied as small with a high hazard potential is between one-half of the Probable Maximum Flood (PMF) and the PMF. Since the reservoir stage of 450 acre-feet is on the lower side of the small size category, one-half the PMF has been adopted as the Test Flood.

The Corps of Engineers guidelines for "Maximum Probable Flood Peak Flow Rates" give a PMF rate of 2,000 cfs per square mile (CSM) for rolling to mountanous terrain, and a drainage area of 5.5 square miles. This results in a one-half PMF flow of 5,500 cfs.

The reservoir would not attenuate a flood of this magnitude significantly. The peak routed Test Flood outflow would, therefore, be 5,500 cfs, which would create a stage of about 4.8 feet above the stoplog spillway and reach an elevation of about 980.2 feet.

This would be about 3.2 feet above the crest height of the dam. The spillway capacity of 485 cfs is only 9% of the peak Test Flood outflow with the stoplogs in place to elevation 974.4 feet NGVD and is 29% of the peak Test Flood outflow with no stoplogs in place.

5.5 Dam Failure Analysis

The peak downstream flows that would result from the failure of Babbidge Dam are estimated using the procedure suggested in "Rule of Thumb Guidelines for Estimating Downstream Dam Failure Hydrographs." The failure is assumed to occur with the water surface elevation at the dam crest 977 feet NGVD. The outflow prior to dam failure would be 485 cfs, creating a tailwater of 3.7 feet in the channel downstream of the dam.

For an assumed breach width equal to 40% of the dam width at the half-height, the gap in the embankment due to failure would be about 44 feet. The resulting peak failure outflow would 18,500 cfs, which would increase the tailwater stage from 3.7 feet to 19.2 feet.

The peak failure outflow would attenuate to a peak of about 15,900 cfs by the time it reached the road crossing about one mile downstream. The peak stage would be 14.2 feet, enough to cause severe flooding at all six of the houses in this area (see Visual Observations). The culvert and road might also be damaged by such severe flooding. Downstream of this area, Roaring Brook enters Otter Brook, and the wider channel of Otter Brook will also attenuate the peak flow. At the end of the next 6,250-foot reach, the peak flow is attenuated to 12,100 cfs and the peak stage reduced to 12.9 feet. The three houses located along the Otter Brook bank in this reach would also experience severe flooding as a result of the failure flow.

At the end of this reach, Otter Brook joins the Minnewawa Brook, the banks widen, and the stream slope flattens. Some minor damage may be incurred in South Keene, but it is expected that the increased storage available will prevent high, damaging stages.

The appropriate hazard classification is HIGH because of the potential damage to several residential houses and the associated risk of loss of more than a few lives in the event of a dam failure. The downstream impacts of failure of this dam are summarized in the chart of the following page.

DOWNSTREAM IMPACT OF THE FAILURE OF BABBIDGE RESERVOIR

Location	Distance Downstream of Dam (ft.)	Number of Structures	Level Above Stream (ft.)	Flow and Stage Before Failure	Flow and Stage After Failure	Comments
Just Downstream of Dam	-	-	-	485 cfs 3.7 ft.	18485 cfs 19.2 ft.	no significant structures
Houses upstream of road crossing	5300	2 houses	5.3	485 cfs 3.7 ft.	15900 cfs 14.2 ft.	structure damage, danger of loss of life
Road crossing	5300	16' W by 6' H Culvert	-	485 cfs	15900 cfs	possibly damaged
Houses downstream of road crossing	5300	4 houses	8-9	485 cfs ≈4 ft.	15900 cfs ≈14 ft.	structure damage, danger of loss of life
Houses of left bank of Otter Brook	5800	3 houses	6	930 cfs 4 ft.	16800 cfs 14.7 ft.	damage, danger of loss of life

Section 6: Structural Stability

6.1 Visual Observations

There has been no significant displacement nor distress which would warrant the preparation of structural stability calculation, based on assumed sectional properties and engineering factors. Some erosion was noted on the spillway and right end wall.

6.2 Design and Construction Data

There are no calculations of value to a stability assessment available for this dam.

6.3 Post Construction Changes

There have been no known construction changes since the dam was completed in 1931.

6.4 Seismic Stability

The dam is located in seismic zone No. 2 and, in accordance with the recommended Phase I guidelines, does not warrant seismic analysis.

Section 7: Assessment, Recommendations, and Remedial Measures

7.1 Dam Assessment

(a) Condition

The Babbidge Reservoir Dam is in fair condition at the present time.

(b) Adequacy of Information

The lack of in-depth engineering data precludes a definitive review. Therefore, the adequacy of the dam cannot be assessed from the standpoint of reviewing design and construction data. This assessment is based primarily on the visual inspection, past performance, and sound engineering judgment.

(c) Urgency

The engineering studies and improvements described herein should be implemented by the owner within one year of receipt of this Phase 1 Inspection Report.

7.2 Recommendations

It is recommended that the city of Keene retain the services of a registered professional engineer to:

(a) Conduct a detailed hydraulic and hydrologic study to further define the need for and means to increase the project discharge capacity or the ability of the dam to withstand overtopping.

(b) Develop a method to remove all trees and stumps (including the roots), from the embankments, and backfill the resulting voids with suitable compacted material.

(c) Uncover and evaluate the condition and location of the downstream end of the outlet conduit.

(d) Inspect the spillway under low flow conditions.

(e) Repair the concrete on the gatehouse, right end wall, and spillway.

The owner should implement the findings of the above engineering studies.

7.3 Remedial Measures

It is recommended that the owner institute the following remedial measures:

(a) Implement and intensify a program of diligent and periodic maintenance including, but not limited to: mowing embankment slopes; backfilling drainage gullies or animal burrows with suitable, well-tamped soil; and clearing debris from spillways, outlets, and slopes.

(b) Implement a program of annual technical inspections of the dam and its appurtenances, including operation of all outlet works and monthly monitoring of the seepage areas near the downstream right abutment for quantity and turbidity.

(c) Develop a plan for surveillance of the dam during and immediately after periods of intense rainfall and a formal, written system for warning the appropriate officials and the downstream residents in the event of an emergency.

(d) Redeck the timber footbridge across the spillway.

7.4 Alternatives

There are no meaningful alternatives to the above recommendations.

APPENDIX A

VISUAL CHECKLIST WITH COMMENTS

Inspection Team Organization

DATE: May 13, 1981

PROJECT: NH00398
Babbidge Reservoir Dam
Roxbury, New Hampshire
NHWRB No. 206.03

WEATHER: Sunny, warm

INSPECTION TEAM:

Nicholas A. Campagna	Goldberg-Zoino & Assoc.	Team Captain
William S. Zoino	GZA	Soils
Jeffrey M. Hardin	GZA	Soils
Paul Razgha	Andrew Christo Engineers	Structures
Carl Razgha	ACE	Structures

NOTE: Mr. Richard Laramie of Camp, Dresser, & McKee, Inc. performed the hydrologic inspection of this dam on May 7, 1981.

CHECKLIST FOR VISUAL INSPECTION

AREA EVALUATED	BY	CONDITIONS AND REMARKS
DAM EMBANKMENT		
Crest Elevation	NAC	977.0 feet (NGVD)
Current Pool Elevation		974.4 feet
Maximum Impoundment to Date		Unknown
Surface Cracks		None noted
Pavement Conditions		Not applicable
Movement or Settlement of Crest		Slight depression near gatehouse is a result of construction (not settlement)
Lateral Movement		None noted
Vertical Alignment		Good
Horizontal Alignment		Good
Condition at Abutment and at Concrete Structures		Good
Indications of Movement of Structural Items on Slopes		None noted
Trespassing on Slopes		None noted
Vegetation on Slopes	NAC	Heavy tree and brush growth on lower downstream slope, light brush growth on upstream slope.

CHECKLIST FOR VISUAL INSPECTION

AREA EVALUATED	BY	CONDITIONS AND REMARKS
Sloughing or Erosion of Slopes or Abutments	NAC	None noted
Rock Slope Protection - Riprap Failure		Riprap on upstream slope has light brush growth - otherwise good
Unusual Movement or Cracking at or near Toes		None noted
Unusual Embankment or Downstream Seepage	NAC	Slight seepage at right abutment, not significant at the present time (1/2 GPM). Approximately 1 to 2 GPM of seepage from rockfill covering waste pipe outlet. Water was clear with rust-colored staining on the ground
Piping or Boils		None noted
Foundation Drainage Features		None noted
Toe Drains		None noted
Instrumentation System	NAC	None noted
PRINCIPAL SPILLWAY		
Condition of Concrete	PR	Fair
Erosion	PR	Up to 4 inches deep

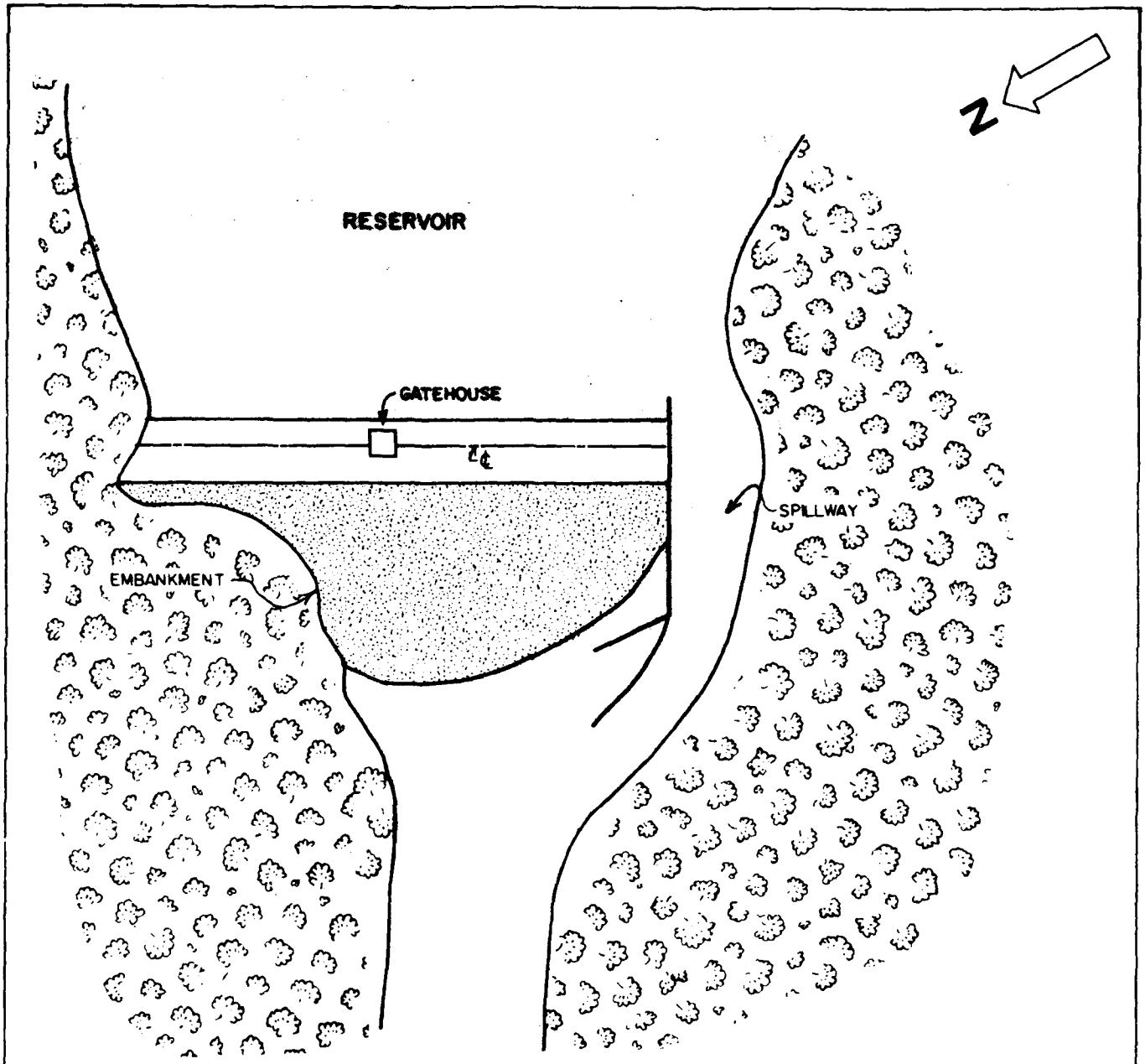
CHECKLIST FOR VISUAL INSPECTION		
AREA EVALUATED	BY	CONDITIONS AND REMARKS
Spalling	PR	None noted
Cracking		None noted
Efflorescence		None noted
Rusting or Staining of Concrete		None noted
Visible Reinforcing		None noted
Wood Footbridge		Plank missing
Metal Railing		Good
LEFT END WALL		
Condition of Concrete		Fair
Erosion		At interface of wall and rock. Erosion at angle point in wall 3 feet long, 18 inches high, and 12 inches deep
Spalling		None noted
Cracking		Minor
Efflorescence		None noted
Rusting or Staining of Concrete		None noted
Visible Reinforcing	PR	At angle point in wall

CHECKLIST FOR VISUAL INSPECTION

AREA EVALUATED	BY	CONDITIONS AND REMARKS
GATEHOUSE		
Foundation	PR	Erosion 12 inches high, 12 inches wide, and 6 inches deep at left upstream corner
Bearing Walls		Good
Wood Framed Roof	PR	Good
RESERVOIR AREA		
Slopes	NAC	Generally shallow to moderate slope. Appear to be stable and in good condition

APPENDIX B

ENGINEERING DATA



GOLDBERG ZOINO & ASSOCIATES, INC
GEOTECHNICAL - GEOHYDROLOGICAL CONSULTANTS
NEWTON UPPER FALLS, MASSACHUSETTS

U.S. ARMY ENGINEER DIV. NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASSACHUSETTS

NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

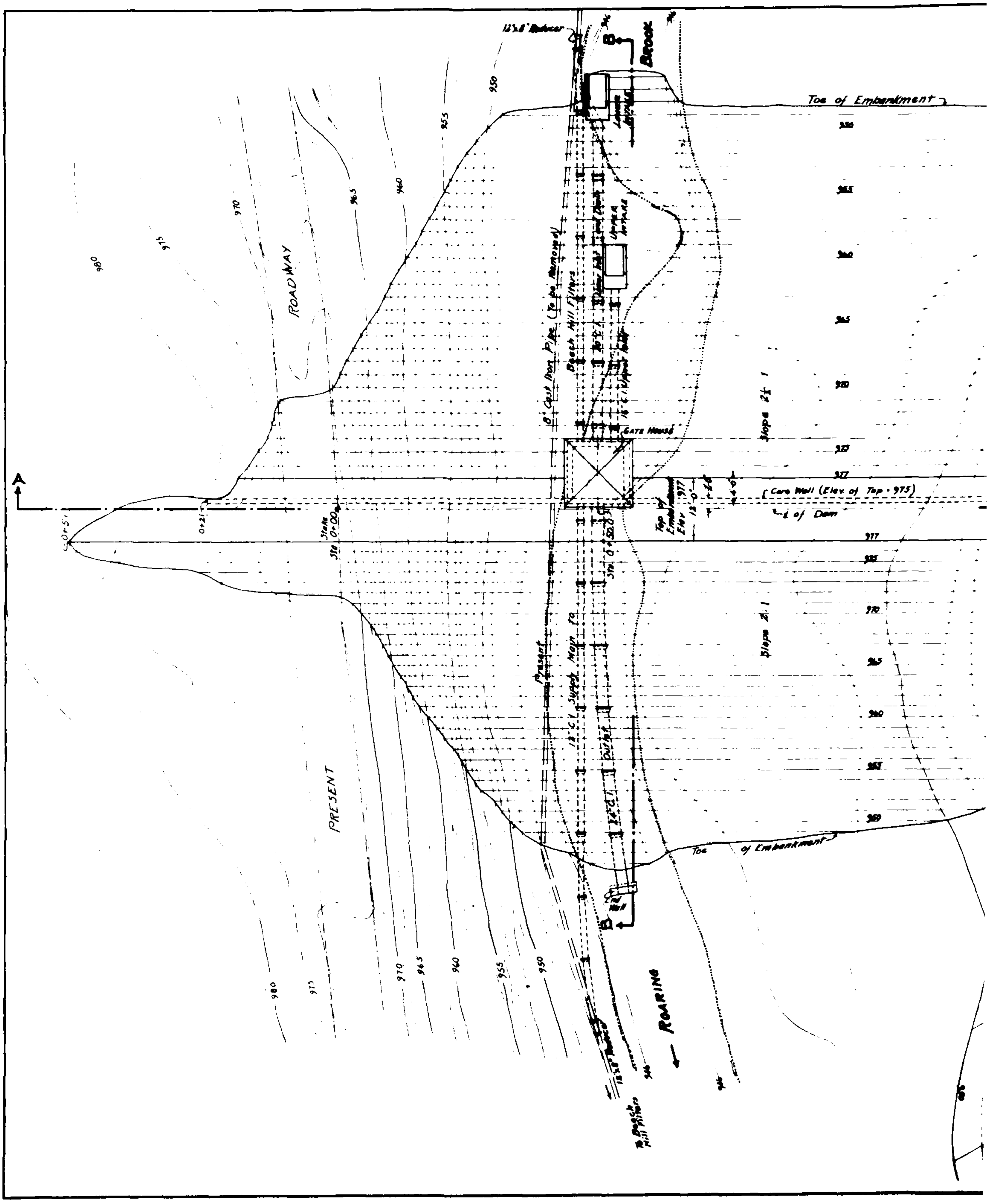
SITE PLAN

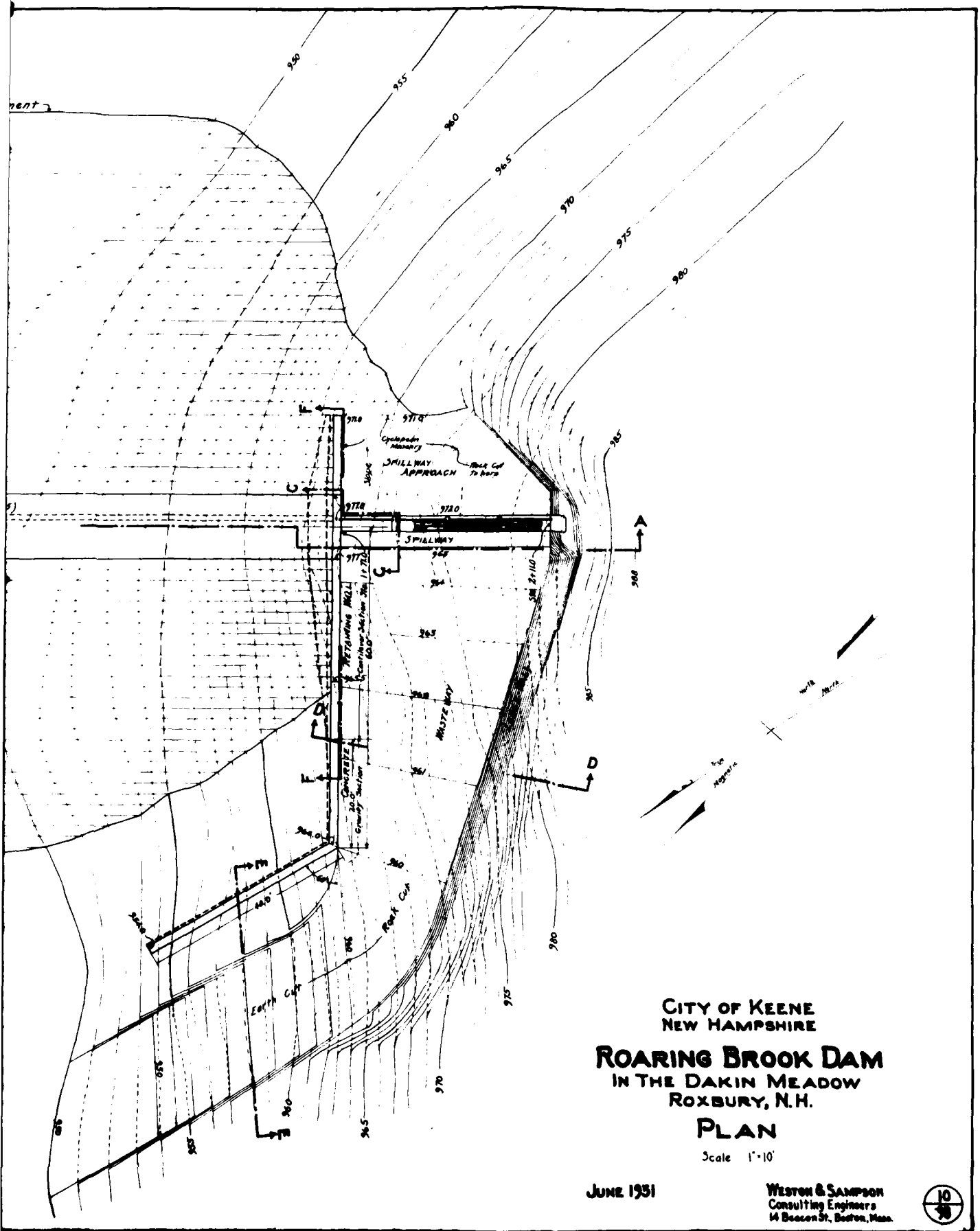
FILE No. 2605

BABBIDGE RESERVOIR DAM — ROXBURY, NEW HAMPSHIRE

SCALE 1" ≈ 60

DATE JUNE 1981


12"x8" Reducer
BROOK
Toe of Embankment
Lower Intake
Upper Intake
ROADWAY
8" Cast Iron Pipe (To be Removed)
Beech Hill Filters
Gate House
Slope 2½:1
Core Wall (Elev of Top - 975)
℄ of Dam
Top of Embankment Elev 977
A
B
Sta 0+00
0+21
0+51
PRESENT
Present
18" C.I. Supply Main to
Outlet
End Wall
Slope 2:1
Toe of Embankment
ROARING
To Beech Hill Filters
950
955
960
965
970
975
980



CITY OF KEENE
NEW HAMPSHIRE

ROARING BROOK DAM
IN THE DAKIN MEADOW
ROXBURY, N.H.

PLAN

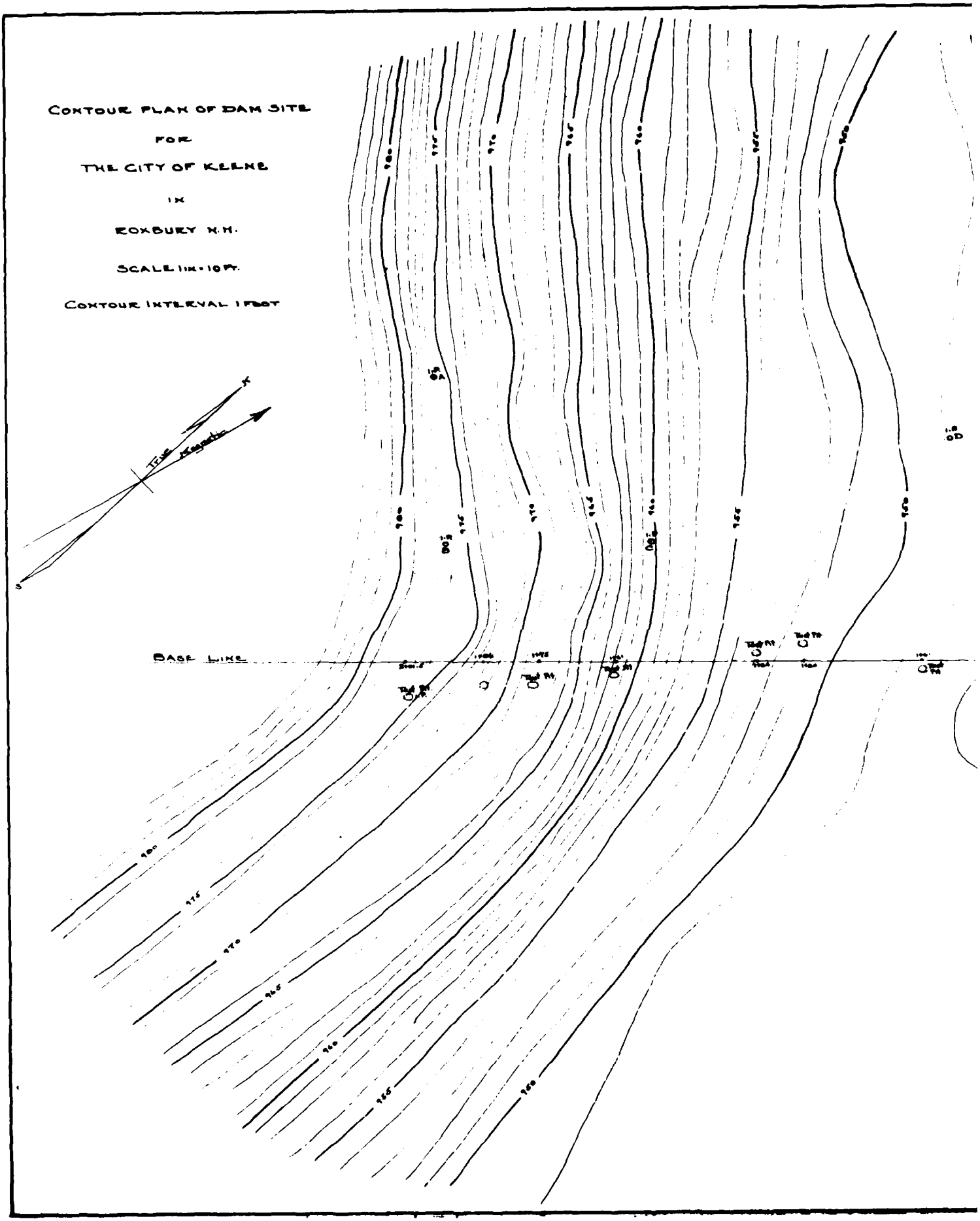
Scale 1" = 10'

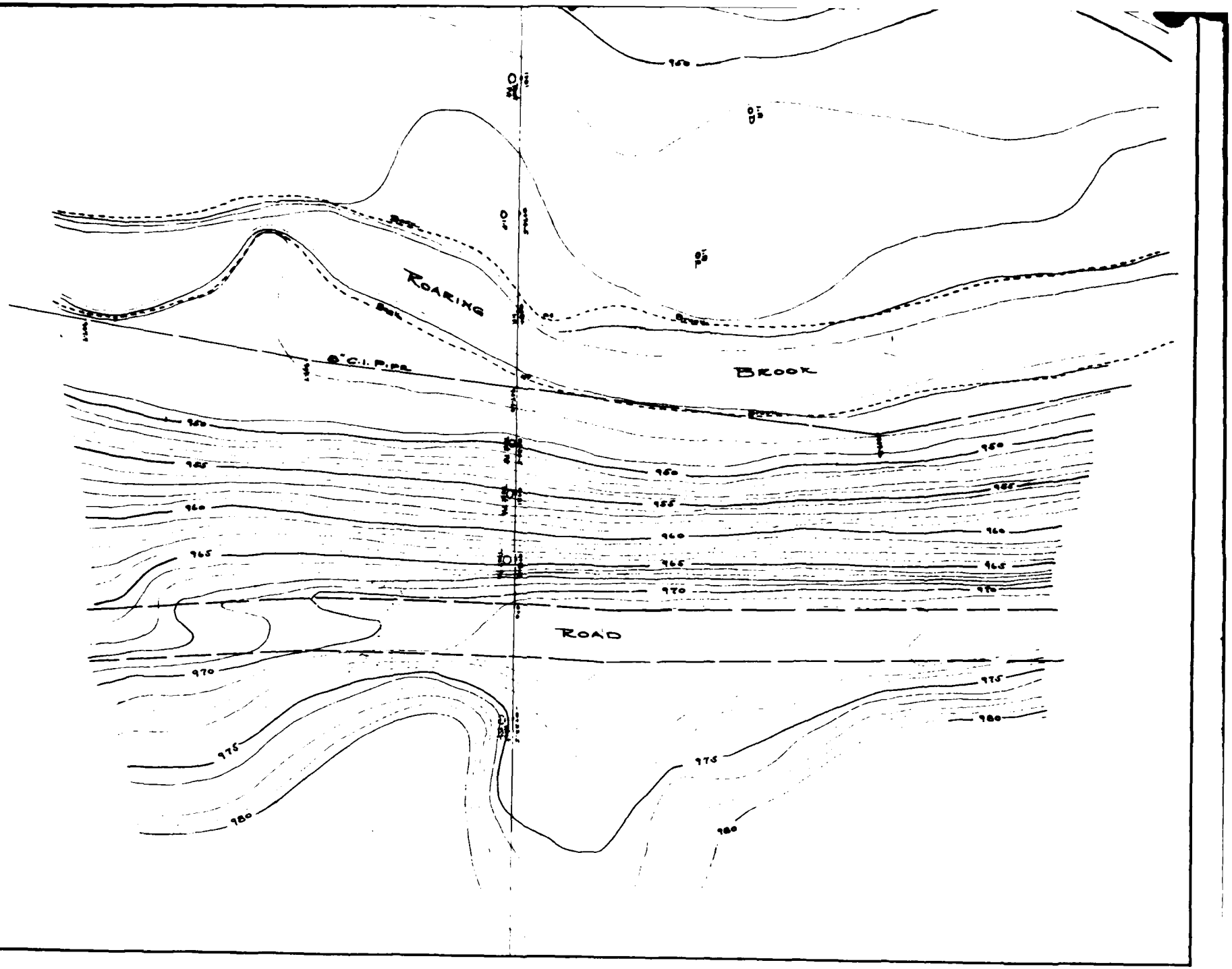
JUNE 1951

WESTON & SAMPSON
Consulting Engineers
14 Beacon St., Boston, Mass.

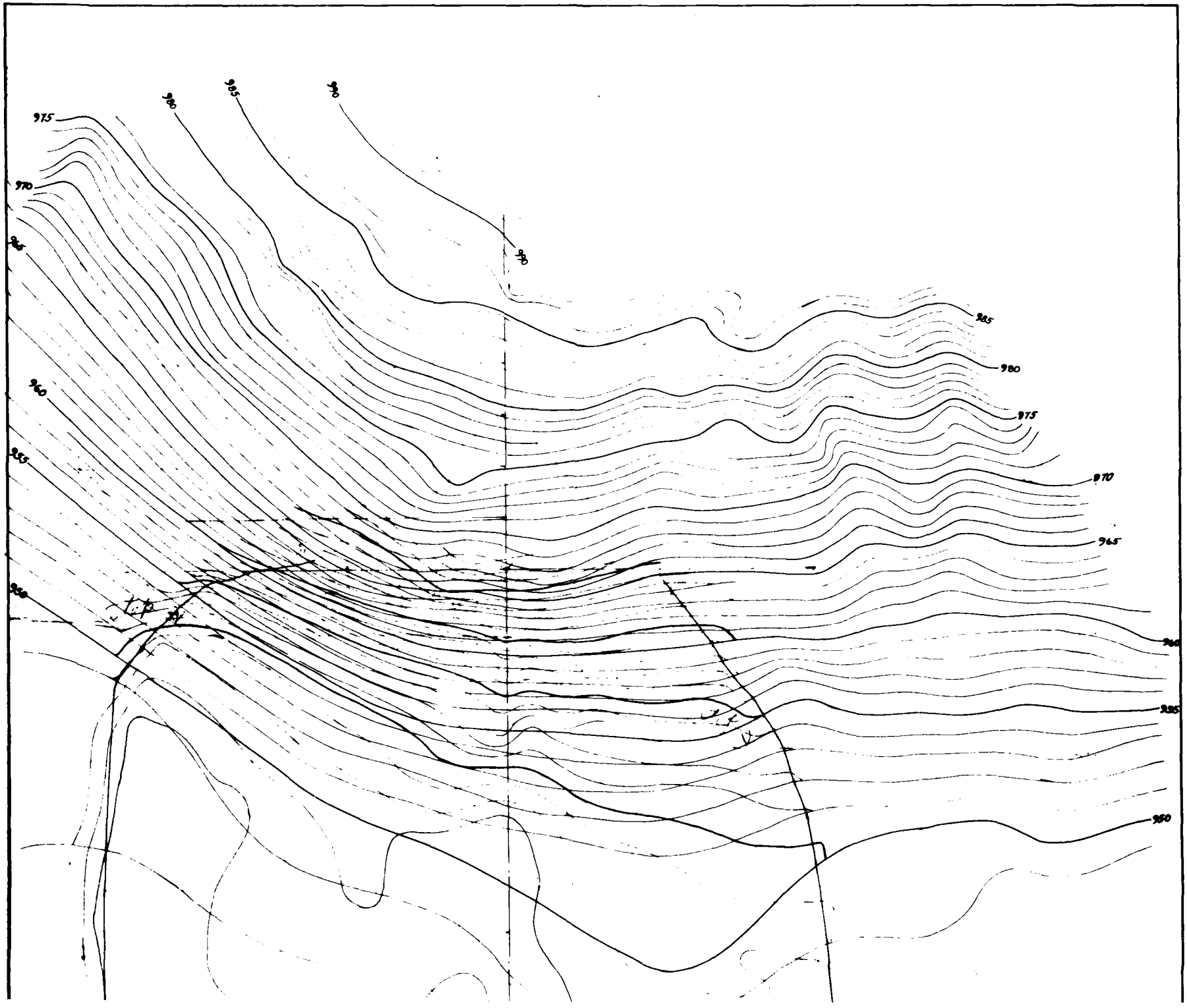
10
98

B-3


CONTOUR PLAN OF DAM SITE
FOR
THE CITY OF KEENE
IN
ROXBURY N.H.
SCALE 1 IN. = 10 FT.
CONTOUR INTERVAL 1 FOOT
True
Magnetic
BASE LINE



B-4


975
980
985
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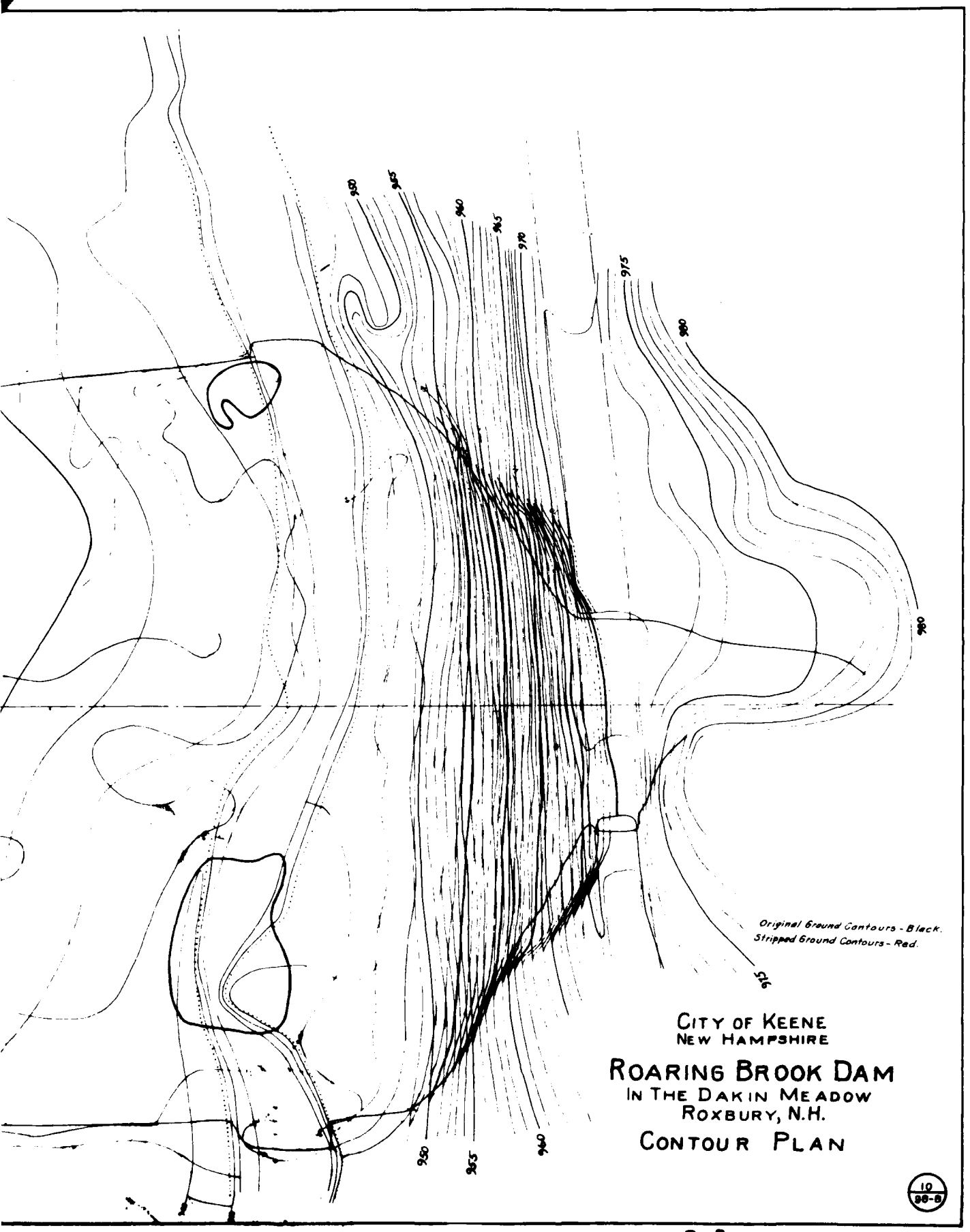
955
950

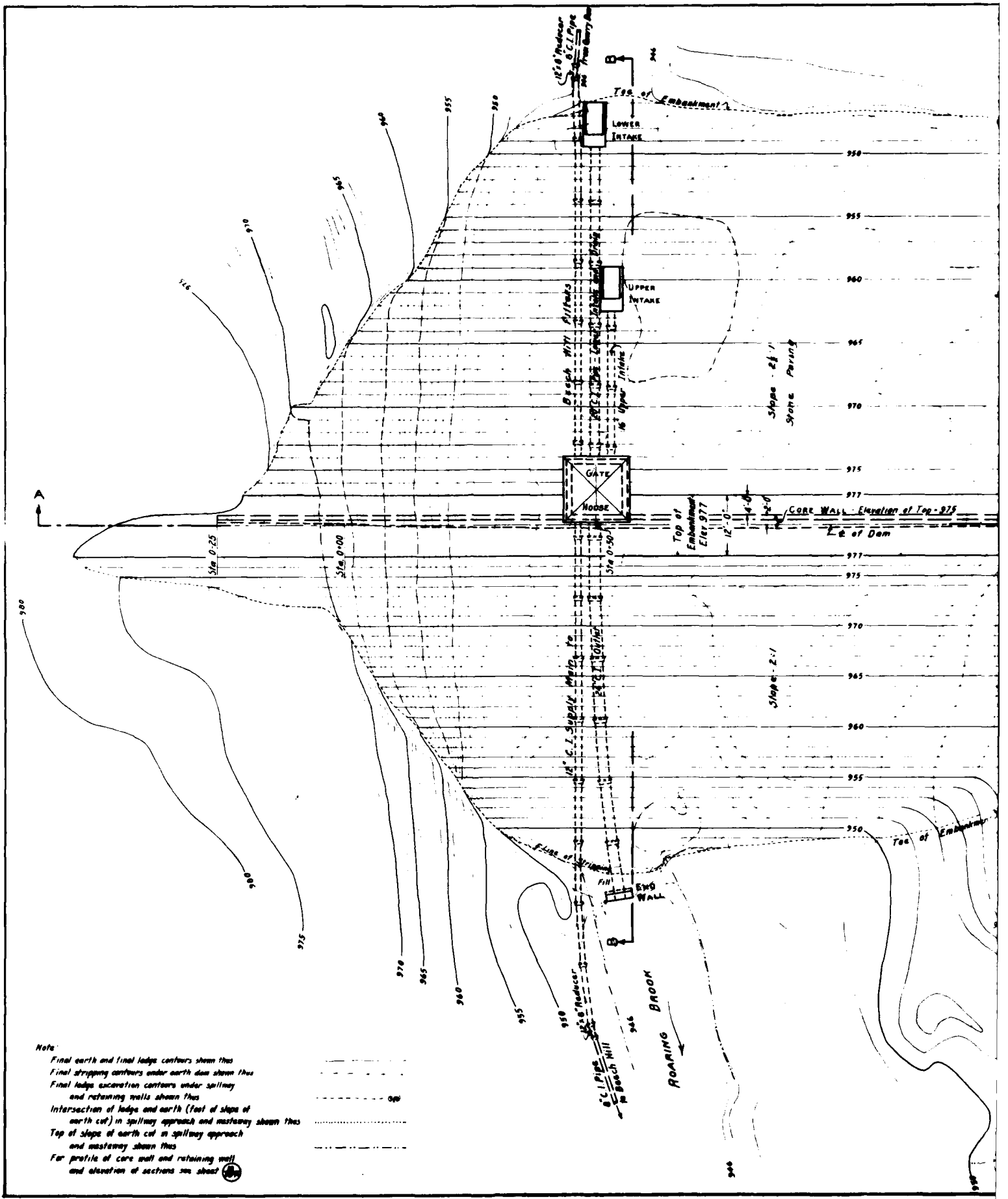


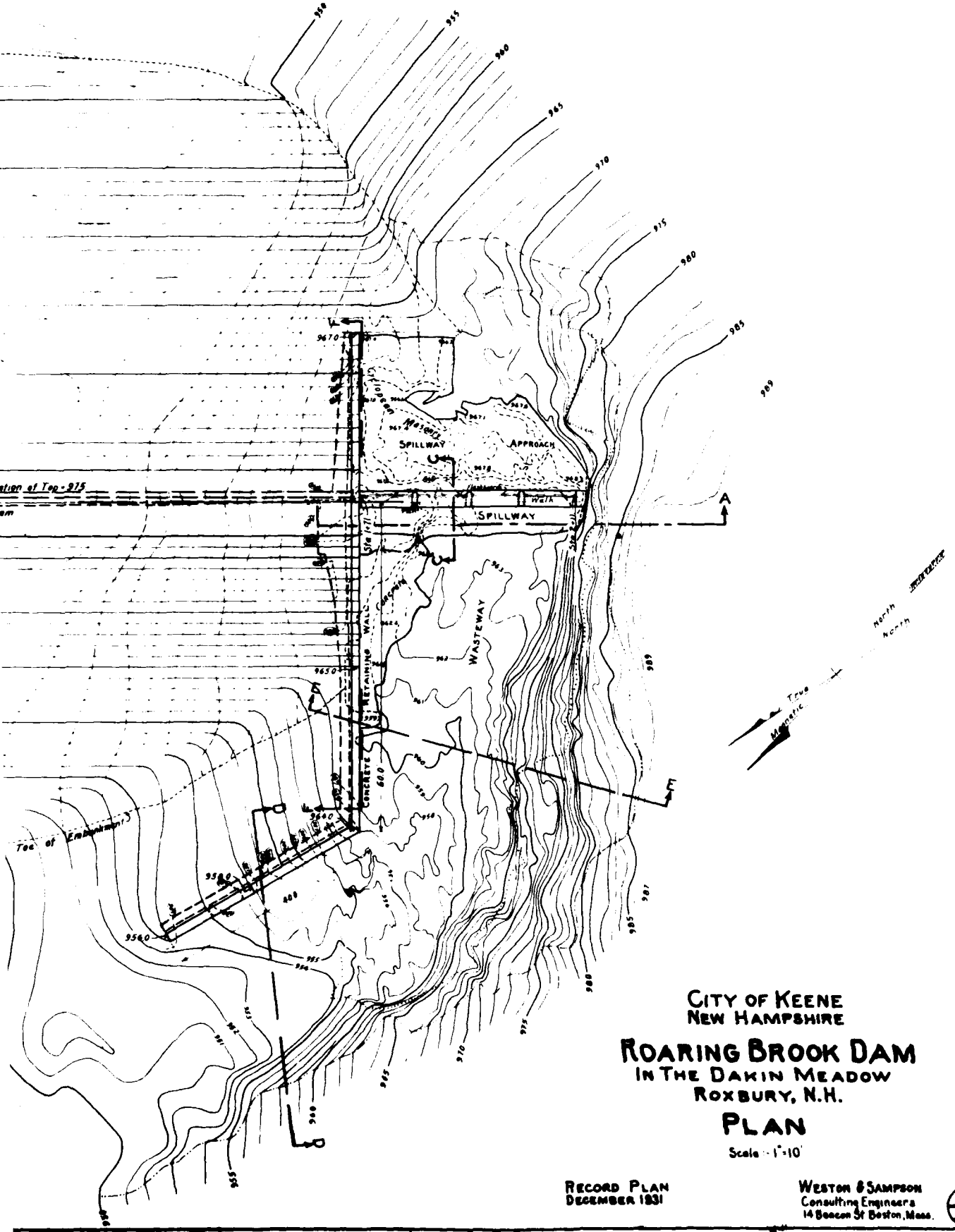
CITY OF KEENE
NEW HAMPSHIRE

ROARING BROOK DAM
IN THE DAKIN MEADOW
ROXBURY, N.H.

CONTOUR PLAN

10
98-8


Top of Embankment
LOWER INTAKE
UPPER INTAKE
GATE HOUSE
Slope 2½:1
Stone Paving
Slope 2:1
Top of Embankment Elev. 977
CORE WALL - Elevation of Top - 975
Ft. of Dam
Sta 0+25
Sta 0+00
Sta 0+50
Toe of Embankment
FISH LADDER
END WALL
ROARING BROOK
Note:
Final earth and final ledge contours shown thus
Final stripping contours under earth dam shown thus
Final ledge excavation contours under spillway and retaining walls shown thus
Intersection of ledge and earth (foot of slope of earth cut) in spillway approach and wasteway shown thus
Top of slope of earth cut in spillway approach and wasteway shown thus
For profile of core wall and retaining wall and elevation of sections see sheet



CITY OF KEENE
NEW HAMPSHIRE

ROARING BROOK DAM
IN THE DAKIN MEADOW
ROXBURY, N.H.

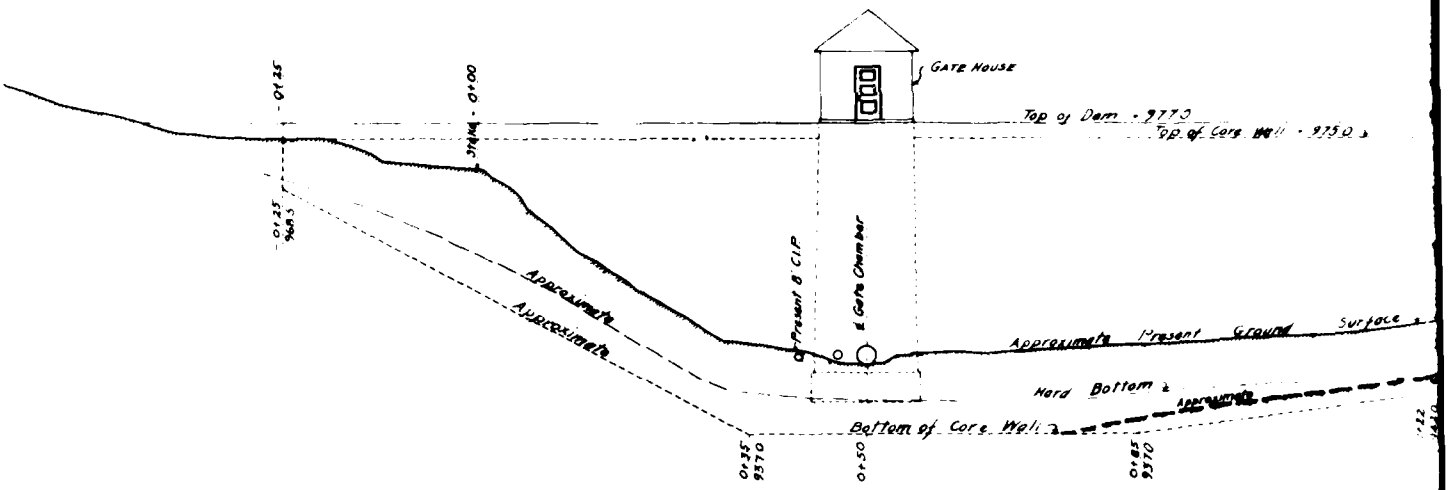
PLAN

Scale - 1"=10'

RECORD PLAN
DECEMBER 1931

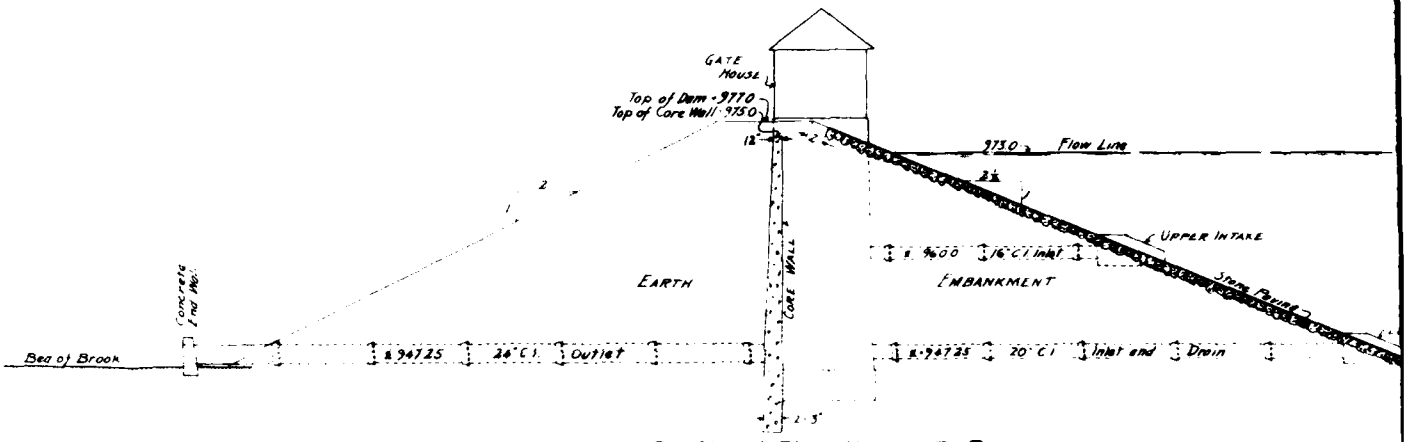
WESTON & SAMPSON
Consulting Engineers
14 Beacon St Boston, Mass.

10/98



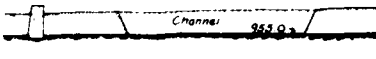
Sectional Elevation on A-A

Scale 1" = 10'



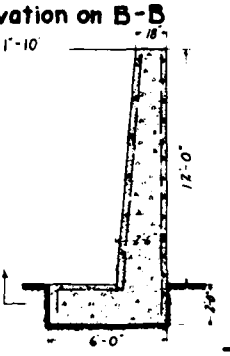
Sectional Elevation on B-B

Scale 1" = 10'

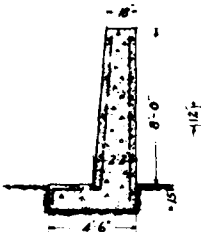


Section of Wasteway on E-E

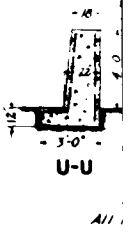
Scale 1" = 10'



S-S



T-T

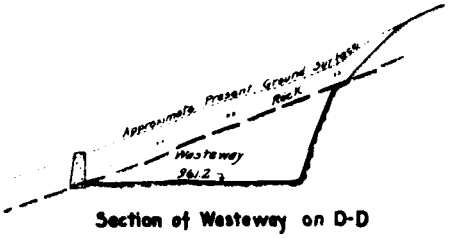


U-U

Vertical Rods Spaced as shown in Sect
Horizontal Rods - Face - 12" c to c
Back - 24" c to c

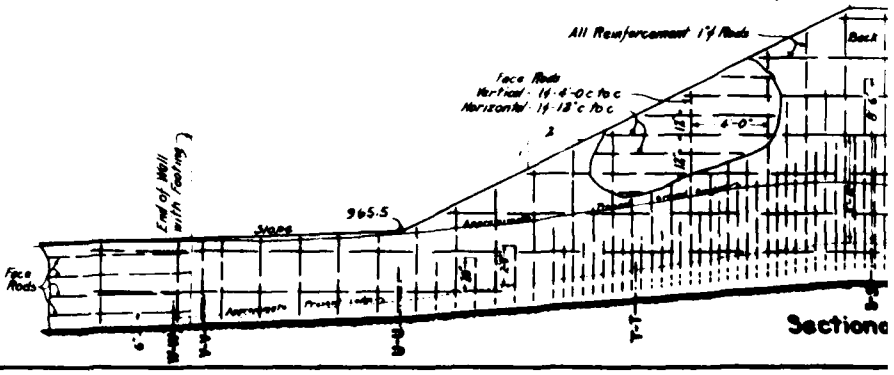
Typical Sections of Retainin

Scale ½" = 1'

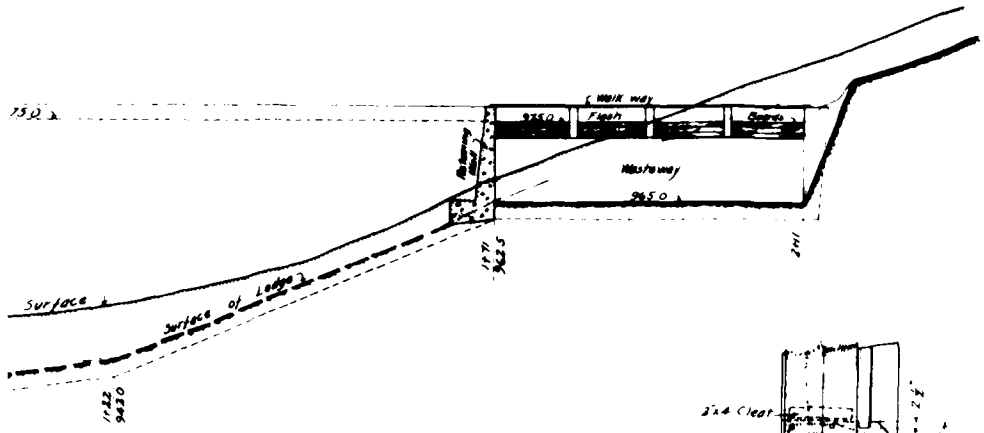


Section of Wasteway on D-D

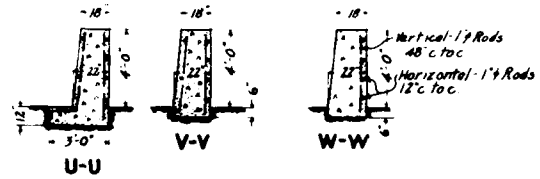
Scale 1" = 10'



Sections

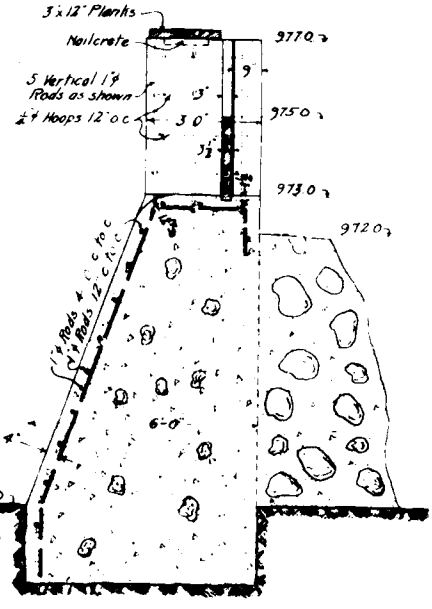


Plan



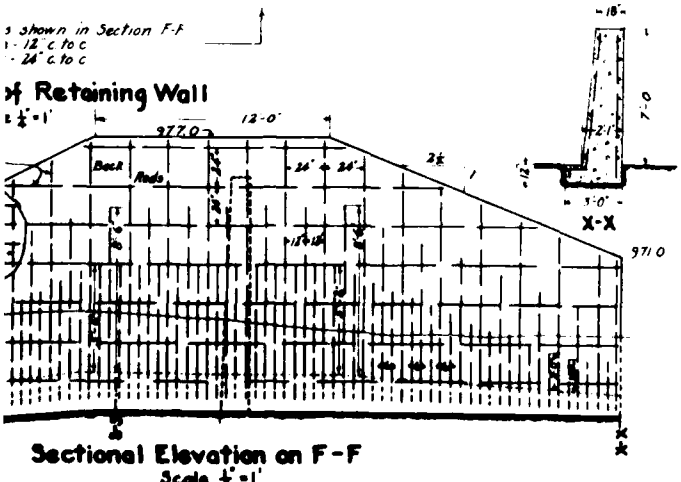
U-U V-V W-W

All Reinforcement - 1"ϕ Rods



Section of Spillway on C-C

Scale 1/2"=1'



Sectional Elevation on F-F

Scale 1/2"=1'

CITY OF KEENE
NEW HAMPSHIRE

ROARING BROOK DAM
IN THE DAKIN MEADOW
ROXBURY, N.H.

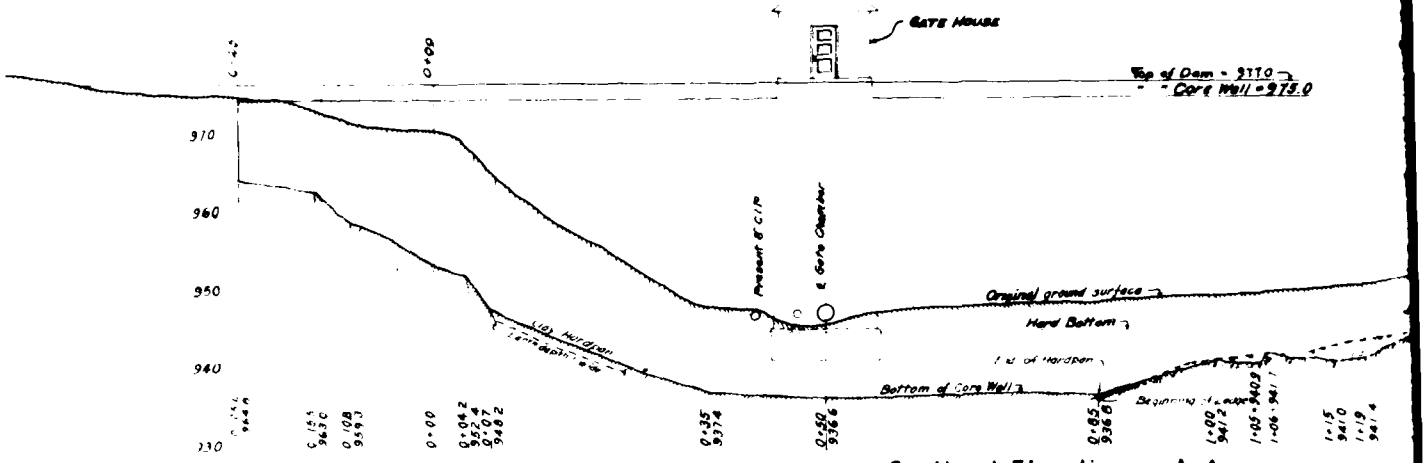
ELEVATION AND SECTIONS

Scales as Noted

JUNE 1931

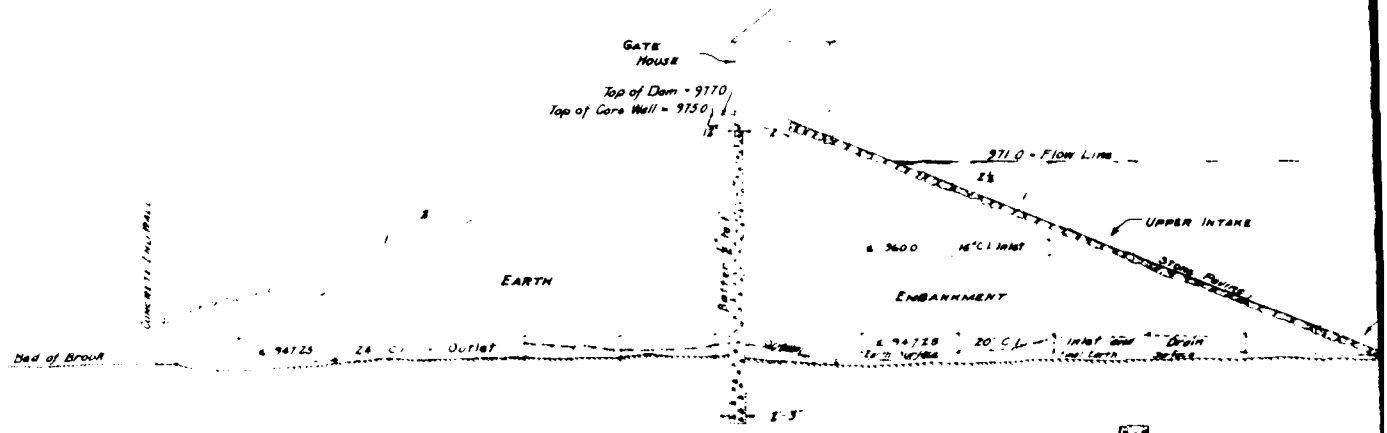
WESTON & SAMPSON
Consulting Engineers
14 Beacon St, Boston, Mass.

10/99



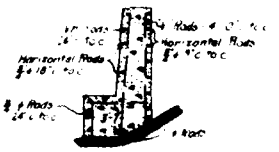
Sectional Elevation on A-A

Scale 1" = 10'



Sectional Elevation on B-B

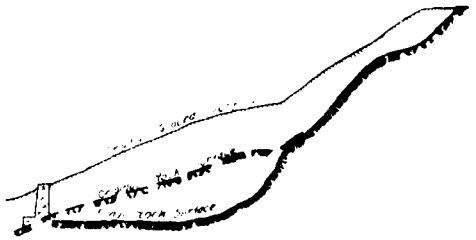
Scale 1"=10'



D-D

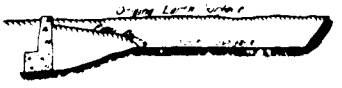
Typical Sections of R

Scale



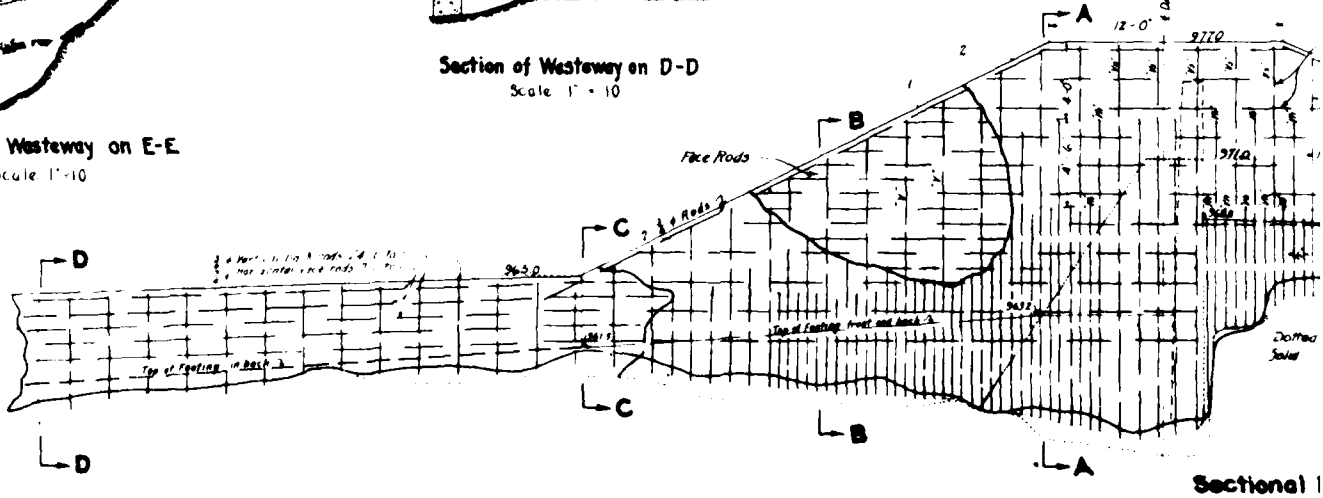
Section of Wasteway on E-E

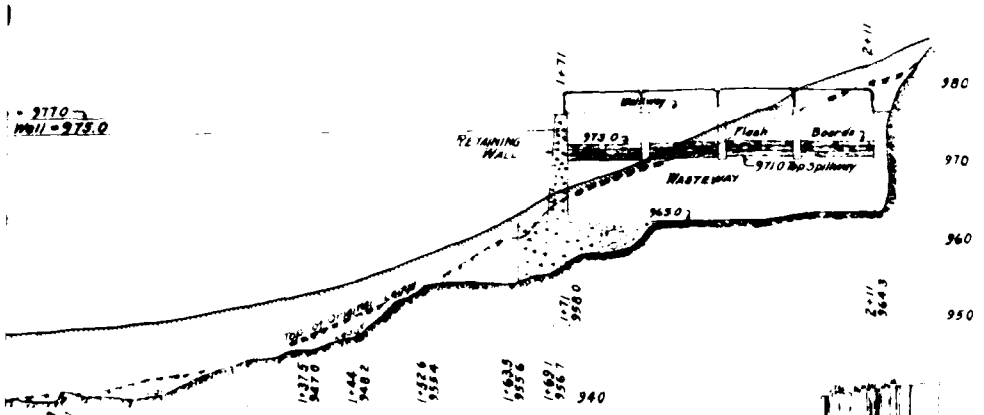
Scale 1"=10'

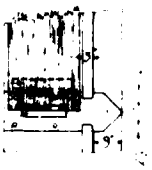


Section of Wasteway on D-D

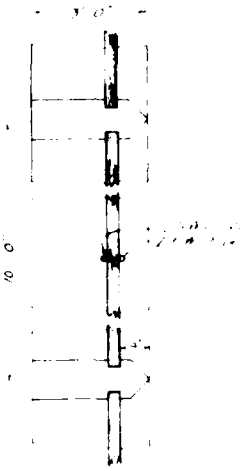
Scale 1" = 10'

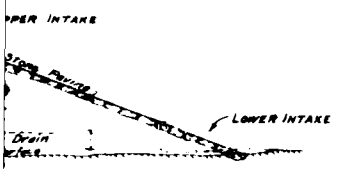


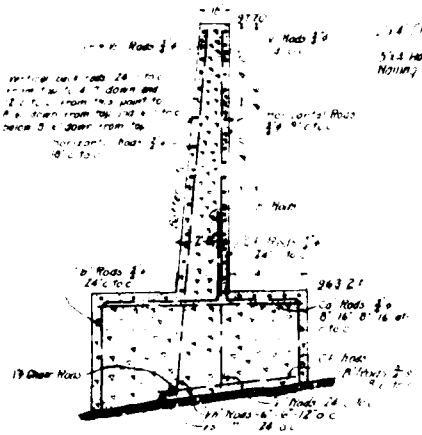




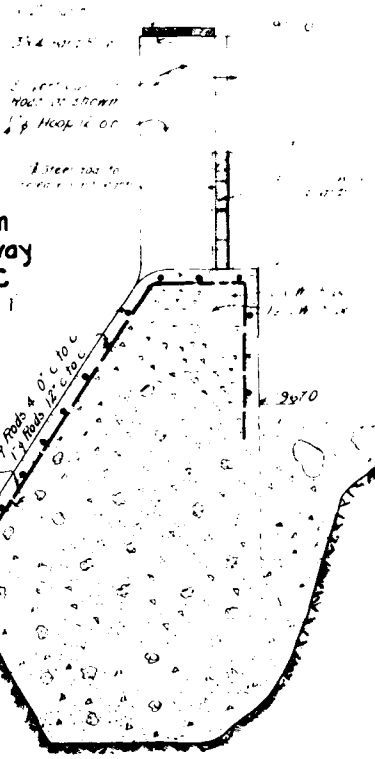
Plan



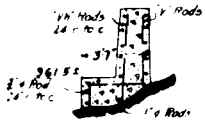




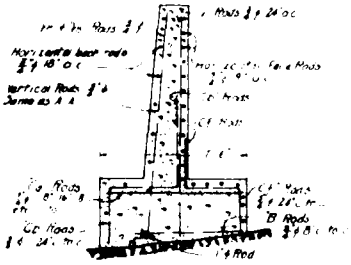
A-A



Section of Spillway on C-C
Scale $\frac{1}{2}$" = 1'

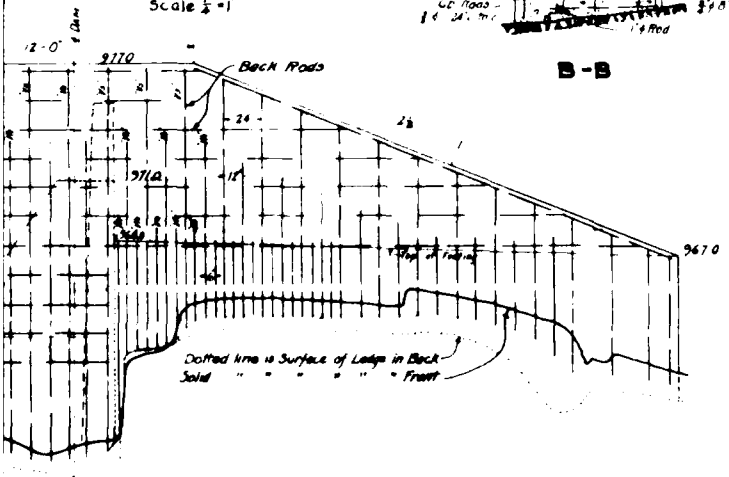


C-C



B-B

Local Sections of Retaining Wall
Scale $\frac{1}{4}$" = 1'



Sectional Elevation on F-F
Scale $\frac{1}{4}$" = 1'

CITY OF KEENE
NEW HAMPSHIRE

ROARING BROOK DAM
IN THE DAKIN MEADOW
ROXBURY, N.H.

ELEVATION AND SECTIONS

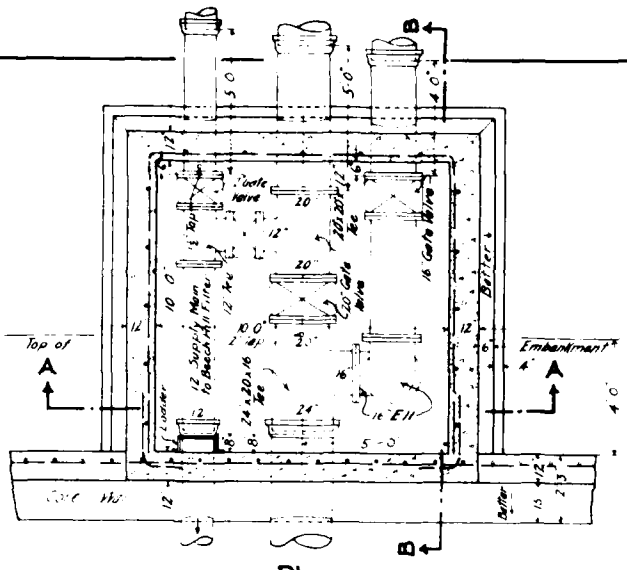
Scales as Noted

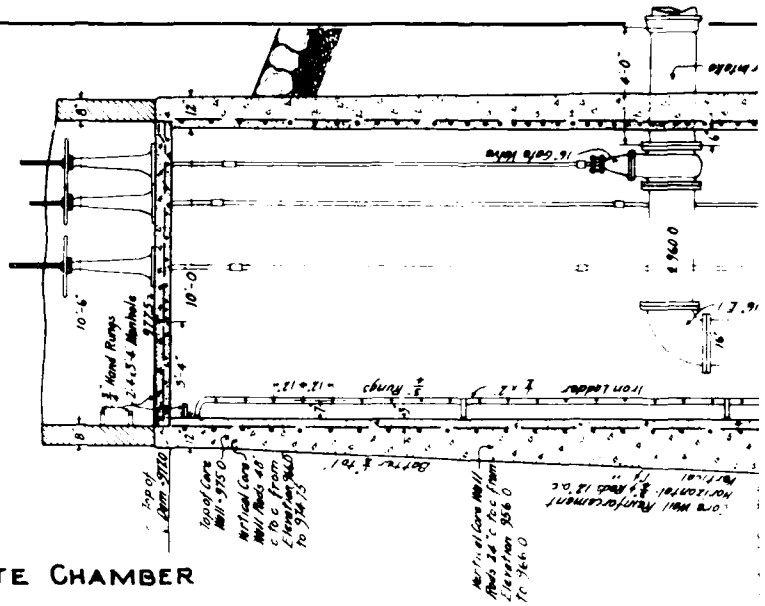
RECORD PLAN
DECEMBER 1931

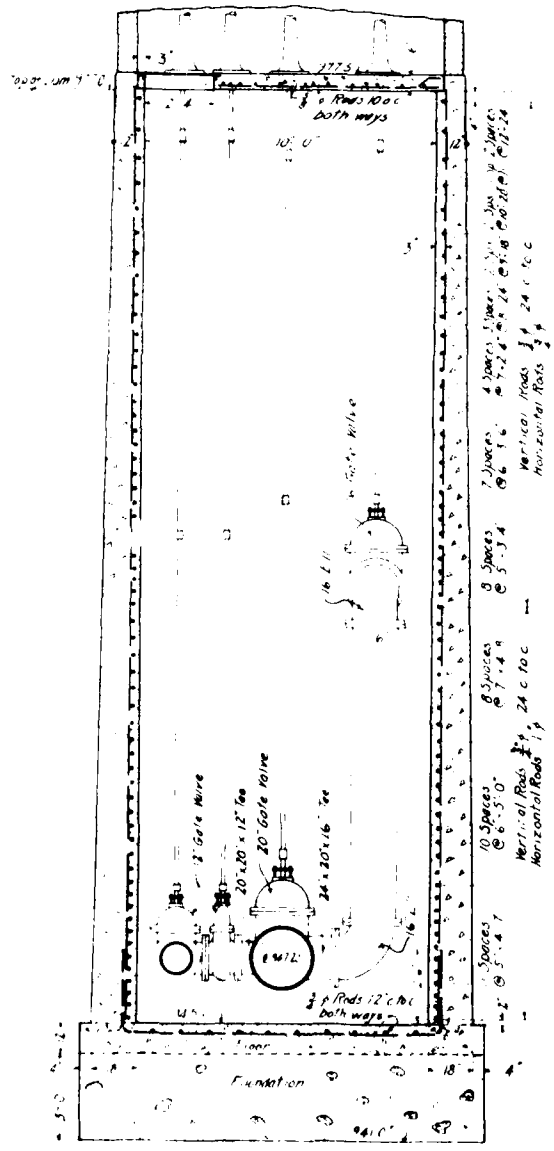
WESTON & SAMPSON
Consulting Engineers
14 Beacon St. Boston, Mass

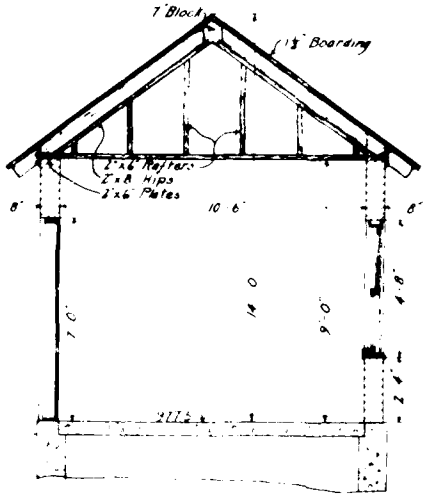
10
99-A

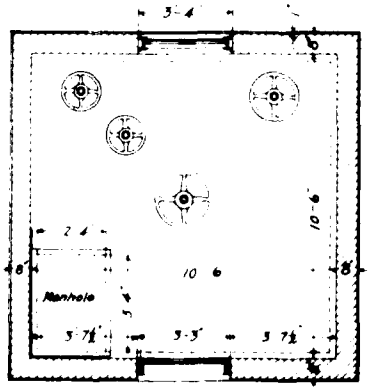
B-8

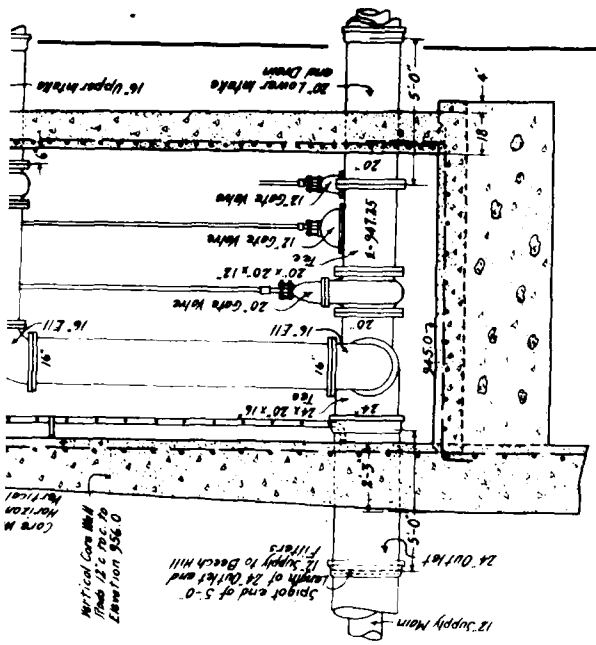

Top of
A
A
Embankment
B
B
Plan


GATE CHAMBER

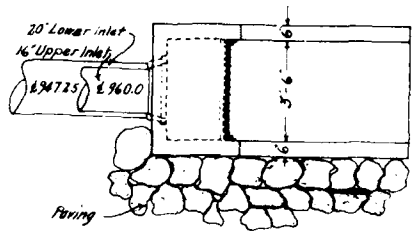

Sectional Elevation on A-A


7" Block
1½" Boarding
2"x6" Rafters
2"x8" Hips
2"x6" Plates
Sectional Elevation

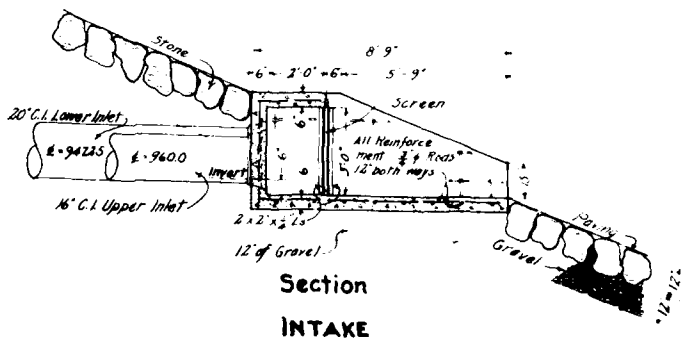

Manhole
Plan
GATE HOUSE



Sectional Elevation on B-B

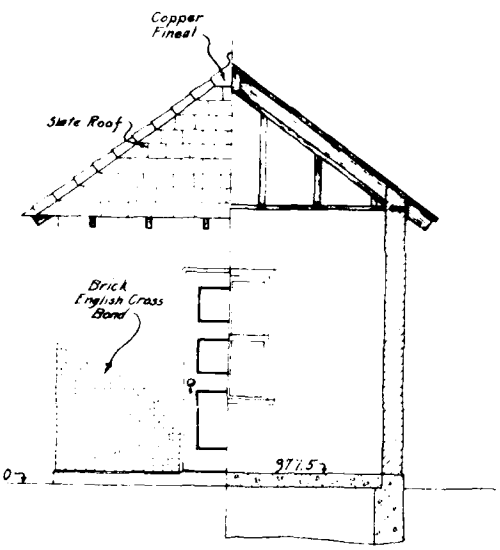


Plan

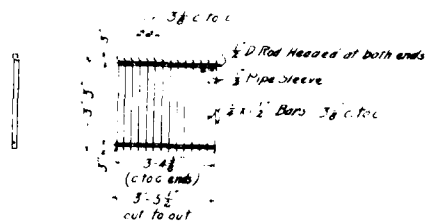


Section

INTAKE
(2 Required)



Half Section **Half Elevation**



W.I. SCREEN
(2 Required)

CITY OF KEENE
NEW HAMPSHIRE

ROARING BROOK DAM
IN THE DAKIN MEADOW
ROXBURY, N.H.

GATE CHAMBER, GATE HOUSE AND DETAILS

Scale 3/8" = 1'

JUNE 1931

WESTON & SAMPSON
Consulting Engineers
14 Beacon St., Boston, Mass.

10/100

NEW HAMPSHIRE WATER RESOURCES BOARD
U. S. CORPS OF ENGINEERS
INVENTORY OF DAMS

Film Roll No. 3

Picture Seq. 15-22

SITE EVALUATION DATA

Quad Monadnock

ID No. 79

NH No. 20603 Inspection Date May 5, 1980 By C E Hale

COE No. 398 Town Roxbury

NAME OF IMPOUNDMENT Pebble Ledge Pond

POPULAR NAME

OWNER(S) Keene

ADDRESS

ZIP CODE:

RIVER OR STREAM Otter Brook Tributary

EXISTING DOWNSTREAM DEVELOPMENT

DOWNSTREAM HAZARD: 3 = Low (2) = Significant 1 = High NO Hazard

TYPE OF DAM: Earth, Rockfill, Gravity, Buttress, Arch, Timber Crib

Other With concrete step log section

PURPOSE: Irr., Hydro., Fld. Control, Water Supply, Rec., Wildlife Mgt.

Other 3:1 upstr. slope 2:1 downstr.

HEIGHT: Structural 28' Hydraulic 28'

POND SIZE (acres) 10 acres ± (30) AVERAGE DEPTH (feet) 15'

DAM CREST LENGTH (bank to bank) 255'

SPILLWAY: Controlled, Uncontrolled, None WIDTH 39' FREEBOARD 5.9'

OUTLET WORKS 4 bays 9.2' long 5.9' high steplog section, 3.4' of step log at present

REMARKS

spillway section - top of steplog section to base of structure on ledge is 13.9'

D.A. 5.5 Sq Mi.

CITY OF KEENE

NEW HAMPSHIRE 03431

January 13, 1977

RECEIVED
G.M.M.Sr.
NEW HAMPSHIRE
WATER RESOURCES BOARD

Mr. George M. McGee, Sr.
State of New Hampshire
Water Resources Board
Concord, New Hampshire 03301

Dear Mr. McGee:

This letter is in reference to your letter dated December 20, 1976 pertaining to to (Dam #206.01 and Dam #206.03) and letter dated January 5, 1977 pertaining to (Dam #126.03).

As of this date, all work done has been completed as per your request on Dam #206.03.

The work on Dam #206.01 will be started in May 1977 when the snow has gone and spring conditions permit vehicles being able to get to this dam.

This work should be accomplished within two (2) weeks from the starting date.

Dam #126.03, the work will start during the week of January 17th and should be completed by February 1, 1977.

Very truly yours,

George M. Gline

GEORGE M. GLINE
DIRECTOR OF PUBLIC WORKS

GMG:eam

NEW HAMPSHIRE WATER RESOURCES BOARD

INSPECTION REPORT

Town: Roxbury Dam Number: 206.03

Name of Dam, Stream and/or Water Body: Babbage Res

Owner: Keene Water Works Telephone Number:

Mailing Address:

Max. Height of Dam: 16' Pond Area: 32 Length of Dam: 215'

FOUNDATION: Hardpan & Ledge

OUTLET WORKS: 4 - 9' Stoplog sections water about 3' above crest
16" & 12" Water System Intake pipe
20" waste pipe

ABUTMENTS:

EMBANKMENT: Earth Embankment 2½ To 1 water with Riprap 2:1 downstream With may Trees

Note: Give Sizing, Condition and detailed description for each item, if applicable.

SPILLWAY: Length: 4 @ 9' Freeboard: Total 6'

SEEPAGE: Location, estimated quantity, etc.

Changes Since Construction or Last Inspection:

Tail Water Conditions:

Overall Condition of Dam: Good

Contact With Owner:

Date of Inspection: 30 Nov 76 Suggested Reinspection Date

Class of Dam:

Signature

Date

Note: Give Sizing, Condition and detailed description for each item, if applicable.

State of New Hampshire

WATER RESOURCES BOARD

CONCORD 03301

Dec. 20, 1976

Director,
Keene Water Works
Keene, N. H 03431

Dear Sir:

Under the provisions of RSA 482, Section 8 thru 15, on Nov. 30, 1976, an engineer of the Water Resources Board staff inspected four dams in the Town of Roxbury owned by the Keene Water Works. These dams, on Woodward Pond (Dam #206.01)and on Babbage Reservoir (Dam #206.03) are classifed in the files of this office as menace structures and as such must be maintained in a manner not to endanger public safety nor become a dam in disrepair.

As a result of this inspection it was noted that several items of maintenance or repairs in need of attention.

Woodward Pond (Dam #206.01)

1. The west abutment wall at the overflow spillway is cracked and is tipping into the spillway. This is to be repaired to prevent water from washing around the spillway

2. There is a small area to the West of the outlet pipe where water appears to be seeping under or through the embankment. This seepage is to be stopped to prevent the possible undermining and washout of the embankment.

Babbage Reservoir (Dam #206.03)

1. Trees that are on the embankment are to be removed. This is to prevent possible damage by the roots or an entire tree being uprooted.

Because these dams are classified as menace structures we require that you send us a proposed schedule of repairs within thirty days. This is not to say that the work is to be completed or even started within this time but that we would like your anticipated dates that this work will take place.

If we can be of any assistance or you have any questions please contact us at your convenience.

Very truly yours,

George M. McGee, Sr.
Chairman

GMMG:scb:ebs

WATER CONTROL COMMISSION

STATE OF NEW HAMPSHIRE

Concord, New Hampshire

October 13, 1938.

Keene Water Board,
Keene N H

RE: Babbage Rest Dam. W. C. C. No. 03.03

Gentlemen:

In order that we may determine the magnitude and extent of the flood of September 21-24 just passed, we are requesting the various dam owners in the State to supply us with the following information:

1. Was this dam injured? Ans. No

2. If so, to what extent? Ans. —

3. Did all flashboards go out? Ans. 2 - 9" flashboards.

4. What was the maximum height of water over the permanent crest of spillway? Ans. 3'-6"

5. At what day and hour did the maximum flood height reach your dam? Ans. Some time Sept 22nd. could not get there Really - busy.

6. Any other interesting information regarding the flood or rain fall may be given on the back of this sheet, or attach sheets.

Will you please return this letter with as much information as you can give us as promptly as possible. A self-addressed envelope is attached hereto.

We thank you for your cooperation.

Very truly yours,

Richard S. Holmgren

Richard S. Holmgren
Chief Engineer

CDC:GMB
Enc.

206.03 Babbage Res.

Condition is good
except for slight leaks
thru split stone spillway.
Leaks are not dangerous.

NEW HAMPSHIRE WATER CONTROL COMMISSION
DATA ON DAMS IN NEW HAMPSHIRE

LOCATION STATE NO. 206.03

Town Roxbury : County Cheshire ✓

Stream Babbage Brook

Basin-Primary Connecticut R. : Secondary Ashuelot R.

Local Name [illegible]

Coordinates—Lat. : Long.

GENERAL DATA

Drainage area: Controlled Sq. Mi.: Uncontrolled Sq. Mi.: Total 5.5 ✓ Sq. Mi.

Overall length of dam 215 ✓ ft.: Date of Construction 1931 ✓

Height: Stream bed to highest elev. 16 ✓ ft.: Max. Structure 10 ft.

Cost—Dam : Reservoir

DESCRIPTION Earth fill earth stone and concrete

Waste Gates

Type 1'8" pipe

Number : Size ft. high x ft. wide

Elevation Invert (12') ? : Total Area sq. ft.

Hoist

Waste Gates Conduit

Number : Materials

Size ft.: Length ft.: Area sq. ft.

Embankment

Type

Height—Max. ft.: Min. ft.

Top—Width : Elev. ft.

Slopes—Upstream on: Downstream on

Length—Right of Spillway : Left of Spillway

Spillway

Materials of Construction

Length—Total 409' each ✓ ft.: Net 36 ft.

Height of permanent section—Max. 11' ft.: Min. ft.

Flashboards—Type 2.75 Removable ✓ : Height 2.75 ✓ ft.

Elevation—Permanent Crest : Top of Flashboard

Flood Capacity 2100 cfs.: 300 cfs/sq. mi.

Abutments

Materials:

Freeboard: Max. 6' ✓ ft.: Min. ft.

Headworks to Power Devel.—(See "Data on Power Development")

OWNER City of Keene

REMARKS Condition fair water supply ✓

Tabulation By G.S.W. Date

B4B21284

NEW HAMPSHIRE WATER RESOURCES BOARD

INVENTORY OF DAMS AND WATER POWER DEVELOPMENTS

DAM

BASIN Connecticut NO. 206.03 55 [illegible]
RIVER Babbage Reservoir MILES FROM MOUTH 1.125 D.A.SQ.MI 6.9
TOWN Roxbury OWNER City of Keene
LOCAL NAME OF DAM Babbidge Reservoir
BUILT 1931 DESCRIPTION ~~Stone & Cement~~
Earthfill riprap upstream concrete spill
+ corewall, Hardpan + Ledge foundation
POND AREA-ACRES 10± DRAWDOWN FT. POND CAPACITY-ACRE FT. 460
HEIGHT-TOP TO BED OF STREAM-FT. 16 [illegible] MAX. MIN.
OVERALL LENGTH OF DAM-FT. 735 MAX.FLOOD HEIGHT ABOVE CREST-FT.
PERMANENT CREST ELEV.U.S.G.S. LOCAL GAGE
TAILWATER ELEV.U.S.G.S. LOCAL GAGE
SPILLWAY LENGTHS-FT. 20-[illegible] = 36' FREEBOARD-FT. 6
FLASHBOARDS-TYPE,HEIGHT ABOVE CREST 2.75 removable stop planks
WASTE GATES-NO. WIDTH MAX.OPENING DEPTH SILL BELOW CREST

REMARKS [illegible]
3.1 mi. Otter Bk, Ashuelot R. North Reaming Bk 3.5 mi from [illegible] Otter Bk

POWER DEVELOPMENT

UNITS NO.	RATED HP	HEAD FEET	C.F.S. FULL GATE	KW	MAKE

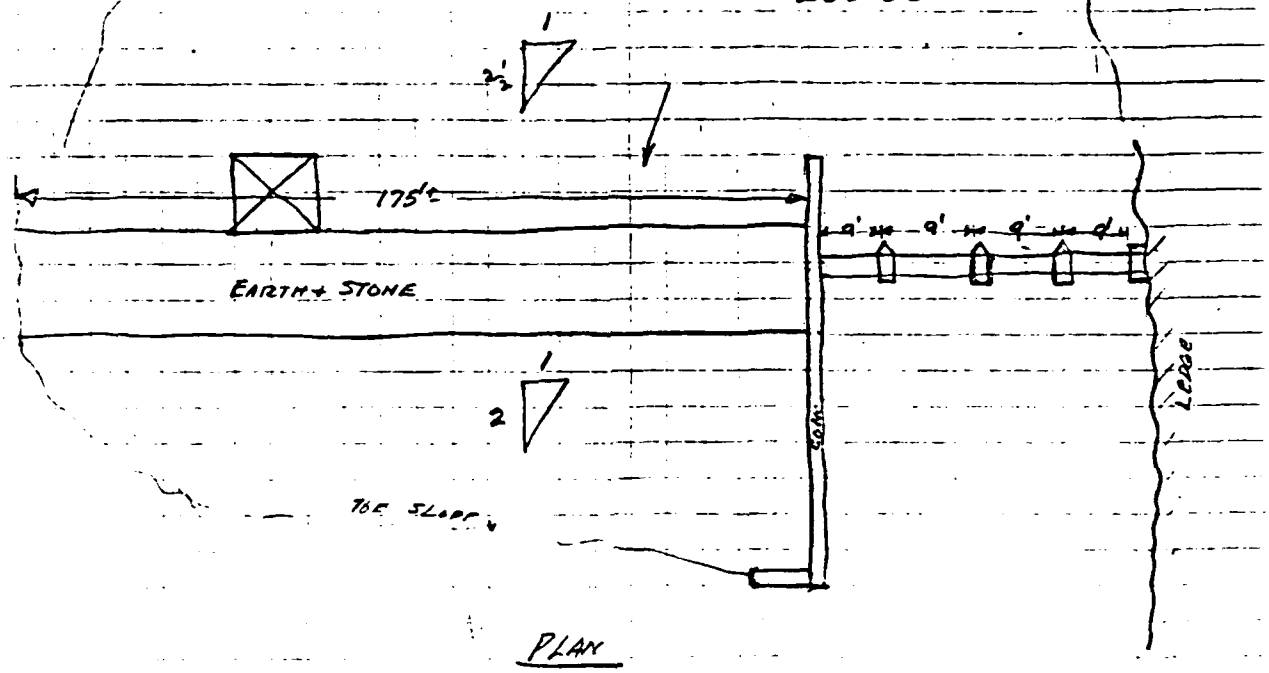
USE Water Supply

REMARKS Owner [illegible] Designed by Weston + Sampson, Boston
[illegible]
Capacity 150,000,000 gal Col Babbidge Supt.

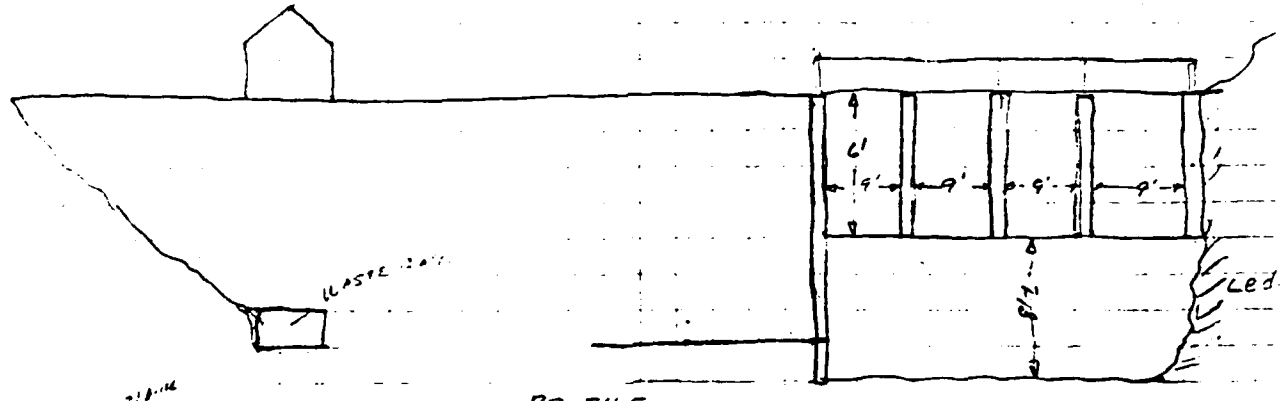
DATE 1935 [illegible]

BABBIDGE RES. - KEENE WATER SUPPLY 11/4/37

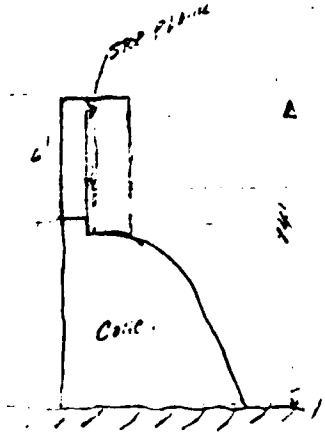
206.03



PLAN



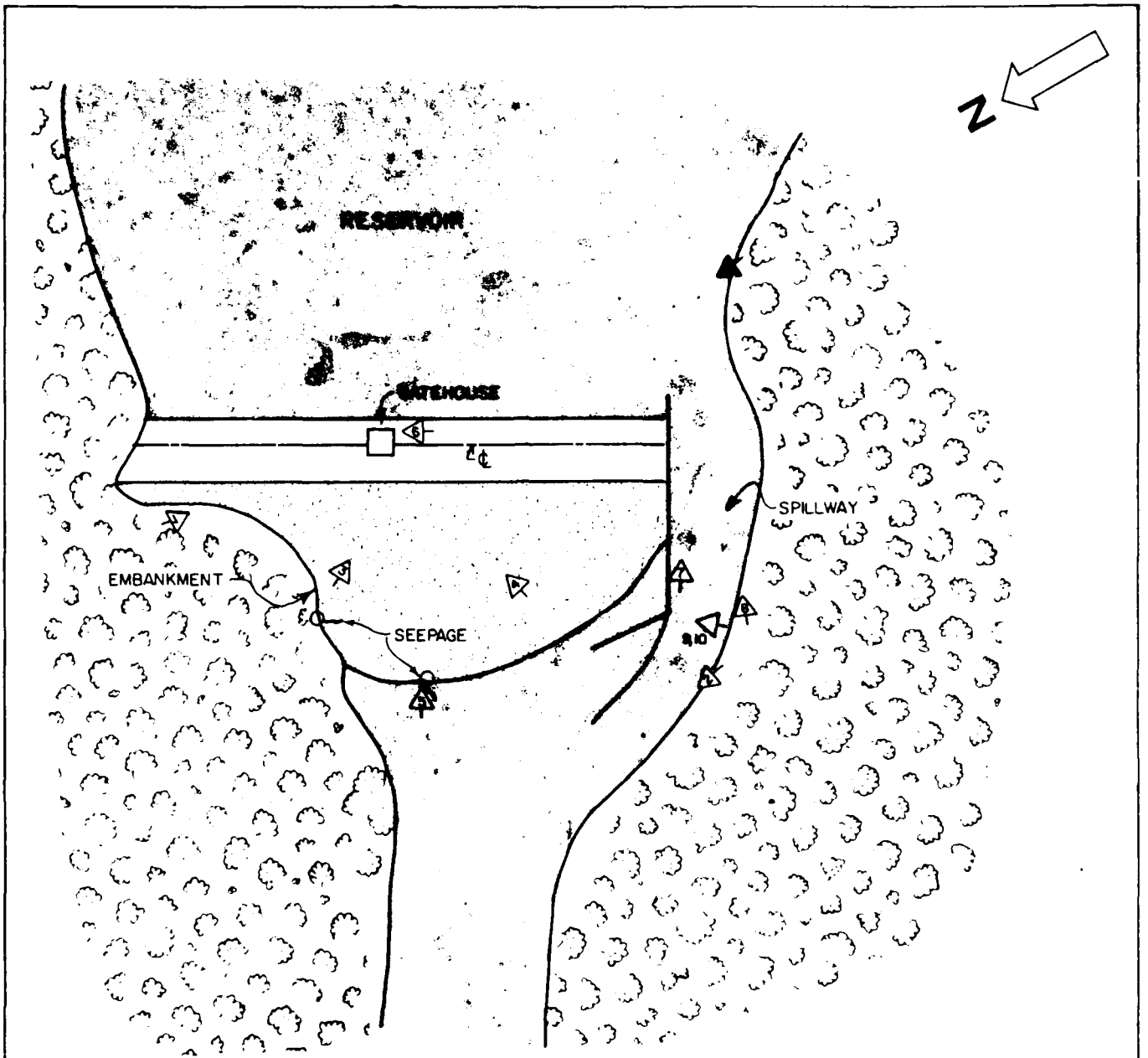
PROFILE



X-SECTION

APPENDIX C

PHOTOGRAPHS



OVERVIEW PHOTO

APPENDIX C PHOTO

GOLDBERG ZOINO & ASSOCIATES, INC
GEOTECHNICAL-GEOHYDROLOGICAL CONSULTANTS
NEWTON UPPER FALLS, MASSACHUSETTS

U.S. ARMY ENGINEER DIV. NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASSACHUSETTS

NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

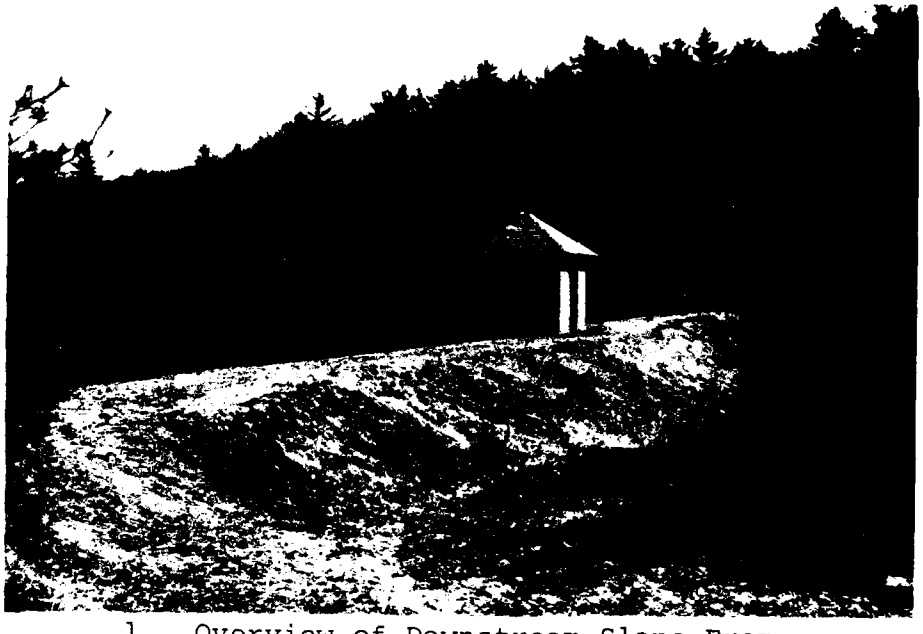
PHOTO LOCATION PLAN

FILE No. 2605

BABBIDGE RESERVOIR DAM ROXBURY, NEW HAMPSHIRE

SCALE 1" ≈ 60

DATE JUNE 1981



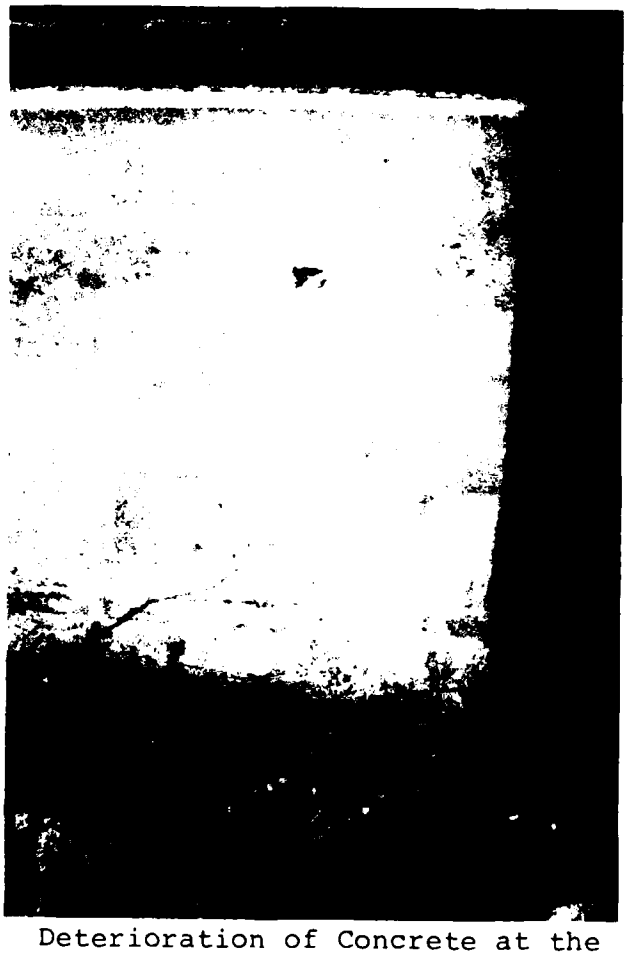
1. Overview of Downstream Slope From Left Abutment

2. Downstream Channel

3. Downstream Right Slope. Note: Tree and Brush Growth

4. Downstream Left Slope. Note: Tree and Brush Growth and Stumps

5. Seepage Emanating From Rock Fill at Downstream Toe. This is Probably the Location of the Outlet Pipe



6. Deterioration of Concrete at the Base of the Gate House

7. Downstream Side of Spillway

8. Downstream Channel Showing Retaining Wall

9. Downstream Section of Retaining Wall

10. Deterioration of Concrete at Bend in Retaining Wall

APPENDIX D

HYDROLOGIC AND HYDRAULIC COMPUTATIONS

BABBIDGE DAM

Babbidge Dam is an earth fill structure with a crest length of 215 feet at elevation 977, and a 36 foot long stop log spillway section. The stop log section consists of four bays each 9 feet wide. The overall length of the dam is 255 feet. Part of the dam structure also contains a gate house with two water supply intake pipes (1.3 and 1.7 foot diameter) and a 2 foot diameter outlet pipe. For the purposes of this report, the outlet pipe will be assumed not opened during flood conditions and hence is neglected from the discharge capacity calculations. Shown on the next page is a sketch of the dam.

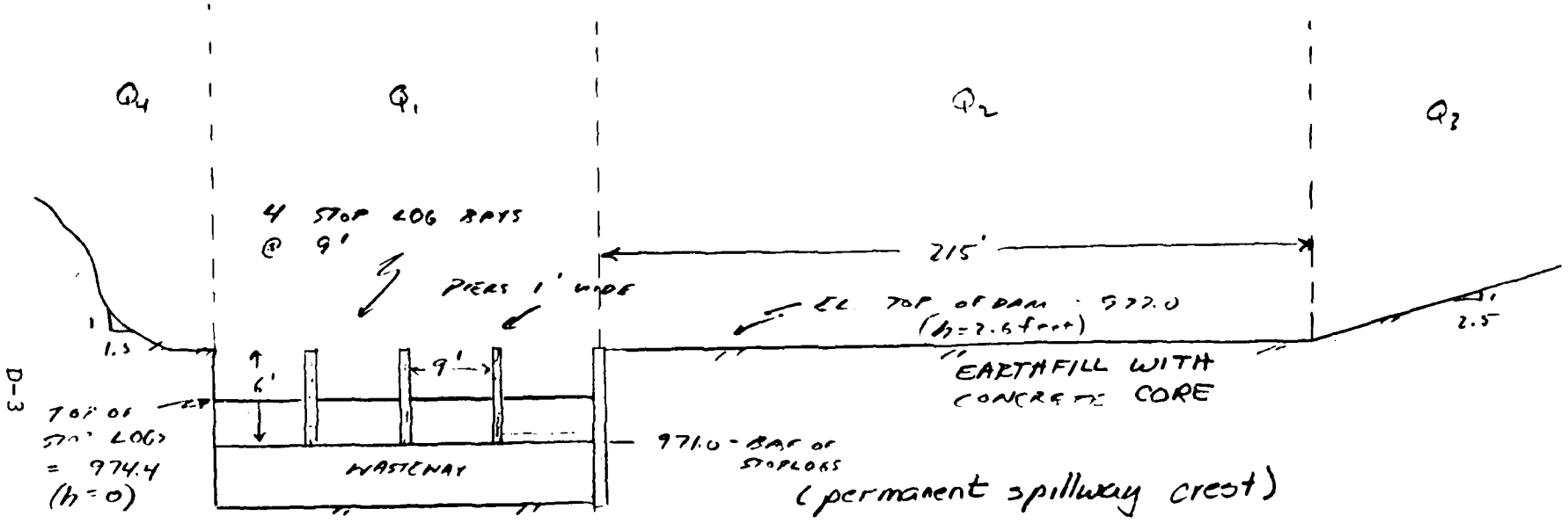
Stage-Discharge Curve

The stage discharge curve applies to the conditions depicted in the sketch. The significant features are:

1. A 215 foot wide dam crest at elevation 977.0.
2. A 36 foot wide stop log section at elevation 974.4.
3. The overbank slopes at 1:1.5 and 1:2.5 for the left and right side of the structure, respectively.

The discharge formulas for these conditions are as follows:

BABBIDGE DAM
(Looking Downstream)



D-3

From Site Plans (December 1931), and Field Notes

NOT TO SCALE

CAMP DRESSER & McKEE INC.

From H = 0 to H = 2.6 feet (H = 0.0 at elevation 974.4)

$$Q_1 = 3.2\ (36)(H)^{1.5}$$

H > 2.6 feet

$$Q_1 = 3.2\ (36)\ (H)^{1.5}$$

$$Q_2 = 3.1\ (215)(H - 2.6)^{1.5}$$

$$Q_3 = 2.8 * 2.5(H - 2.6)(.5(H - 2.6))^{1.5}$$

$$Q_4 = 2.8 * 1.5(H - 2.6)(.5(H - 2.6))^{1.5}$$

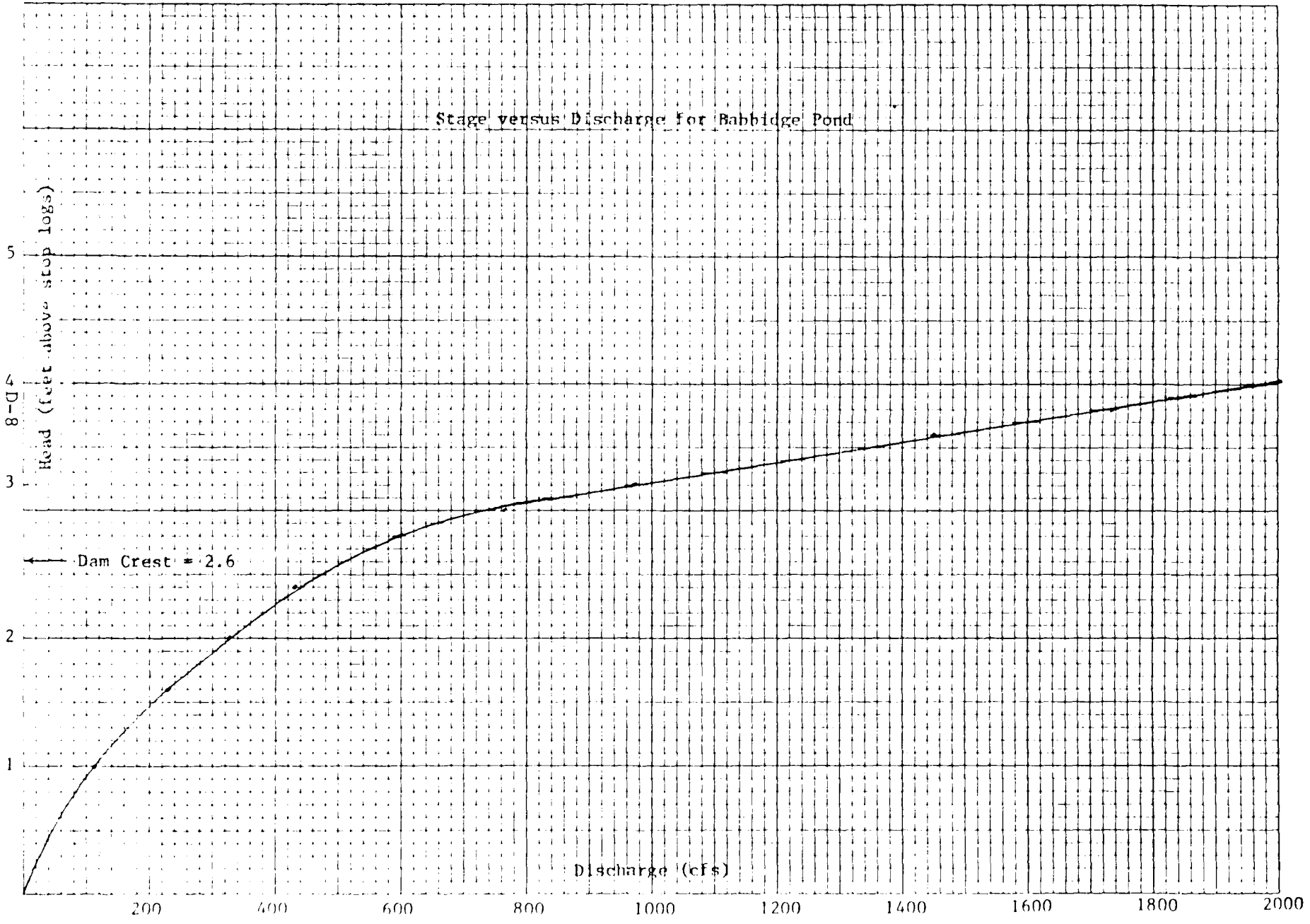
Shown on the next pages are the BASIC program using the above formulas, a stage discharge table and stage-discharge curve.

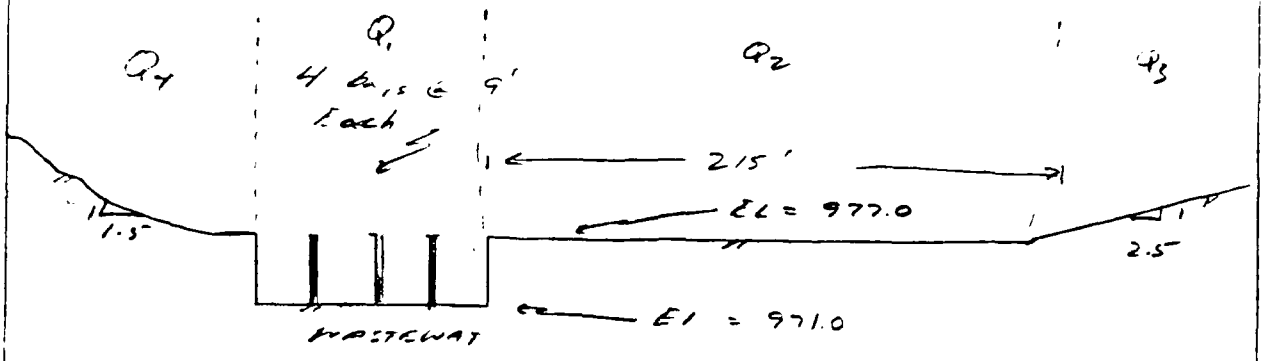
```
100 REM STAGE/DISCHARGE CURVE FOR BABBIDGE DAM
110 REM - STORED ON TAPE B-1 FILE 23
120 PAGE
130 PRINT USING 140:
140 IMAGE 10T"STAGE VS. DISCHARGE RELATIONSHIP FOR BABBIDGE DAM"
150 PRINT USING 160:
160 IMAGE /1T"HEAD"                          30T"DISCHARGE"
170 PRINT USING 180:
180 IMAGE 1T"(FT.ABOVE LOGS)"        32T"(CFS)"//
190 PRINT USING 200:
200 IMAGE 13T"SPILLLWAY"25T"DAM"      35T"ABUTMENTS"47T"TOTAL"//
210 FOR H1=36.4 TO 42.4 STEP 0.2
220 Q1=0
230 Q2=0
240 Q3=0
250 Q4=0
255 Q5=0
256 Q6=0
257 H=H1-36.4
260 Q1=3.2*36*H↑1.5
270 IF H<=2.6 THEN 310
280 Q2=3.1*215*(H-2.6)↑1.5
290 Q3=2.8*2.5*(H-2.6)*(0.5*(H-2.6))↑1.5
300 Q4=2.8*1.5*(H-2.6)*(0.5*(H-2.6))↑1.5
310 Q5=Q1+Q2+Q3+Q4
320 Q6=Q3+Q4
330 PRINT USING 340:H,Q1,Q2,Q6,Q5
340 IMAGE 2D.2D,11D.2D,6D.2D,9D.2D,9D.2D
350 NEXT H1
360 END
```

STAGE VS. DISCHARGE RELATIONSHIP FOR BABBIDGE DAM

HEAD (FT. ABOVE LOGS)	DISCHARGE (CFS)			
	SPILL WAY	DAM	ABUTMENTS	TOTAL
0.00	0.00	0.00	0.00	0.00
0.20	10.30	0.00	0.00	10.30
0.40	29.14	0.00	0.00	29.14
0.60	53.54	0.00	0.00	53.54
0.80	82.43	0.00	0.00	82.43
1.00	115.20	0.00	0.00	115.20
1.20	151.43	0.00	0.00	151.43
1.40	190.83	0.00	0.00	190.83
1.60	233.15	0.00	0.00	233.15
1.80	278.20	0.00	0.00	278.20
2.00	325.83	0.00	0.00	325.83
2.20	375.91	0.00	0.00	375.91
2.40	428.32	0.00	0.00	428.32
2.60	482.96	0.00	0.00	482.96
2.80	539.75	59.61	0.07	599.43
3.00	598.60	168.61	0.40	767.61
3.20	659.44	309.76	1.10	970.31
3.40	722.22	476.91	2.27	1201.40
3.60	786.88	666.50	3.96	1457.34
3.80	853.35	876.14	6.25	1735.73
4.00	921.60	1104.06	9.18	2034.84
4.20	991.58	1348.90	12.82	2353.30
4.40	1063.24	1609.57	17.21	2690.02
4.60	1136.55	1885.15	22.40	3044.10
4.80	1211.47	2174.87	28.43	3414.78
5.00	1287.98	2478.09	35.33	3801.40

5.20	1366.02	2794.22	43.16	4203.40
5.40	1445.58	3122.75	51.95	4620.28
5.60	1526.63	3463.24	61.73	5051.60
5.80	1609.14	3815.27	72.54	5496.95
6.00	1693.09	4178.48	84.41	5955.97





$Q_1 = 3.0\ (36)\ (H)^{1.5}$

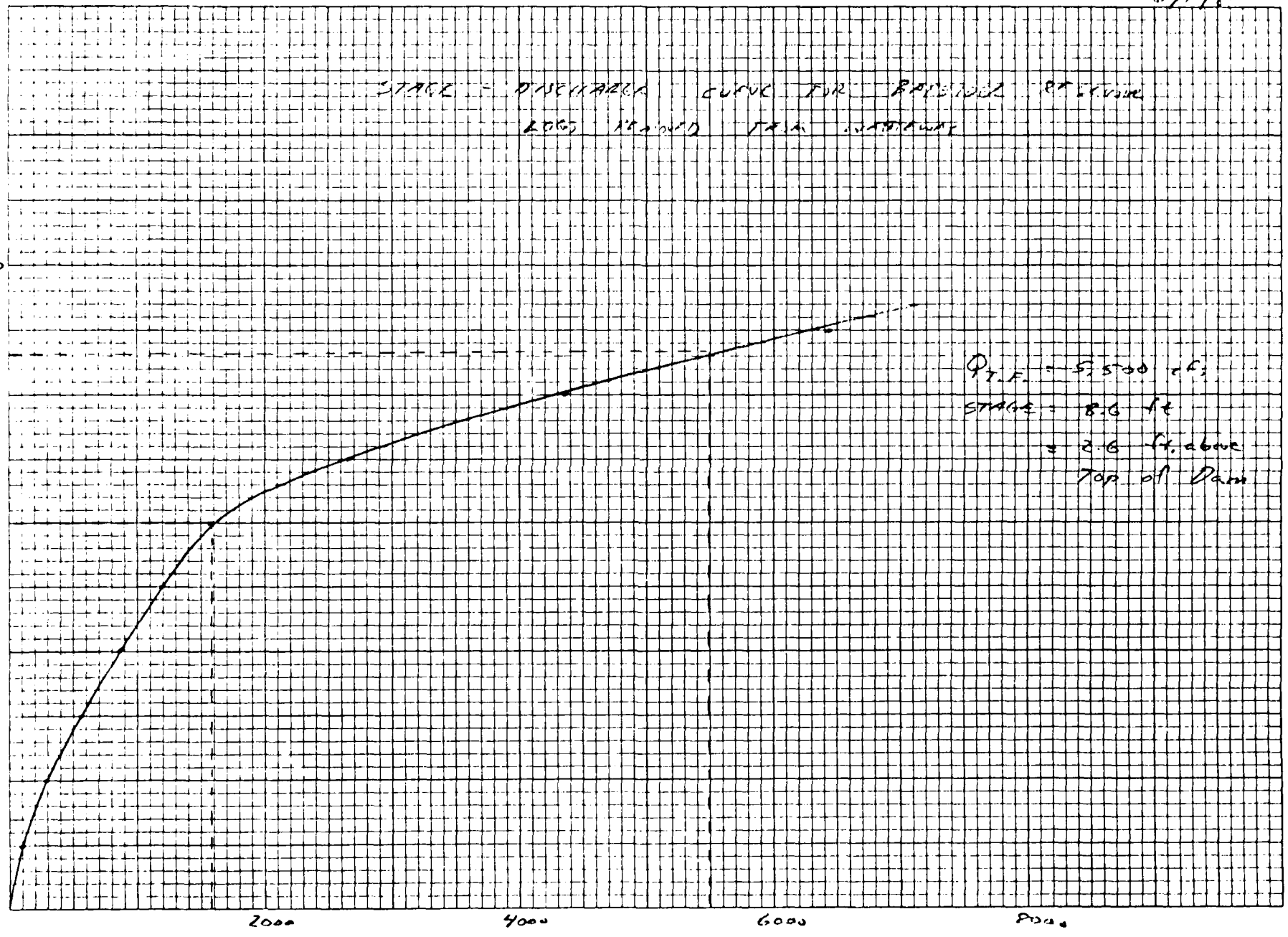
$Q_2 = 3.1\ (215)\ (H-6)^{1.5}$

$Q_3 = 2.8 + 2.5(H-6)\ (.5(H-6))^{1.5}$

$Q_4 = 2.8 + 1.5\ (H-6)\ (.5(H-6))^{1.5}$

LOGS REMOVED - H = ft above MASTERWAY

H	Q_1	Q_2	Q_3+Q_4	TOTAL Q
1	108	0		108
2	305	0		305
3	561	0		561
4	864	0		864
5	1207	0		1207
6	1587	0		1587
7	2000	667	4	2671
8	2444	1885	22	4351
9	2916	3463	62	6441
10	3415	5332	127	8760
11				


STAGE - DISCHARGE CURVE FOR BOTTOM OF LOCK
$Q_{T.F.}$ = 5,500 cfs
STAGE = 8.6 ft
= 2.6 ft. above
Top of Dam
10
9
8
7
6
5
4
3
2
1
2000
4000
6000

FROM RATING CURVE:

Spillway Capacity = 1590 cfs.

Test Flood outflow of 5,500 cfs would create a stage of about 2.6 ft above the dam.

Spillway capacity is $\frac{1590}{5,500} \times 100\% \approx \underline{30\%}$

of the Peak Test Flood Outflow.

Stage-Storage Relationship

The normal storage behind Babbidge Dam (with the water at the stop log elevation) is about 450 acre-feet. The surface area of the pond is about 30 acres. Assuming no spreading as the pond rises:

h = feet above streambed

surcharge storage = 30 (h - 36.4)

total storage = 450 + 30 (h - 36.4)

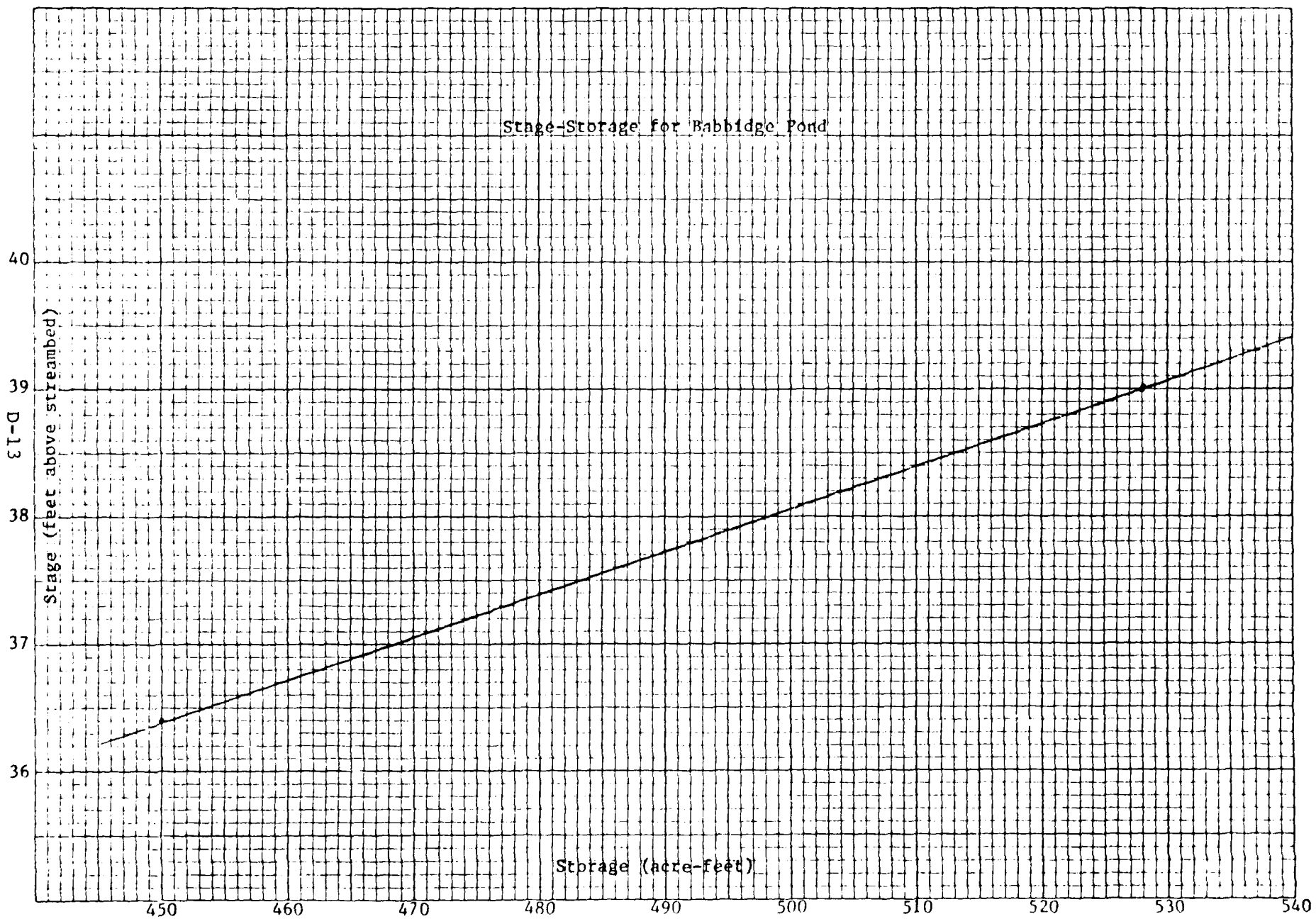
For the drainage area of 5.5 square miles:

$$1 \text{ inch of runoff} = \frac{5.5\ (640)\ 1 \text{ in}}{12 \text{ (in/ft)}} = 295 \text{ acre-feet}$$

$$1 \text{ acre-foot} = \frac{1}{295} = .0034 \text{ inches of runoff}$$

Surcharge storage to dam crest = 30 * (2.6) = 78 acre [illegible] : .27 inches of runoff

At the dam crest, total storage = 450 + 78 = 528 acre-feet.



Dam Failure Analysis

Assume failure occurs when water overtops the dam crest and abutments, h = 2.6, 977 feet msl.

Peak Failure Outflow = Normal Flow + Breach Outflow

Normal Flow, from Discharge Curve = 485 cfs

Breach Outflow = $Q_{pl} = \frac{8}{27} \sqrt{g} W_b Y_o^{3/2}$

Y_o = water surface height above channel invert at failure

= 977 - 938 = 39 feet

$W_b \leq .4$ (width at 1/2 height)

1/2 height = 20 feet; elevation 958

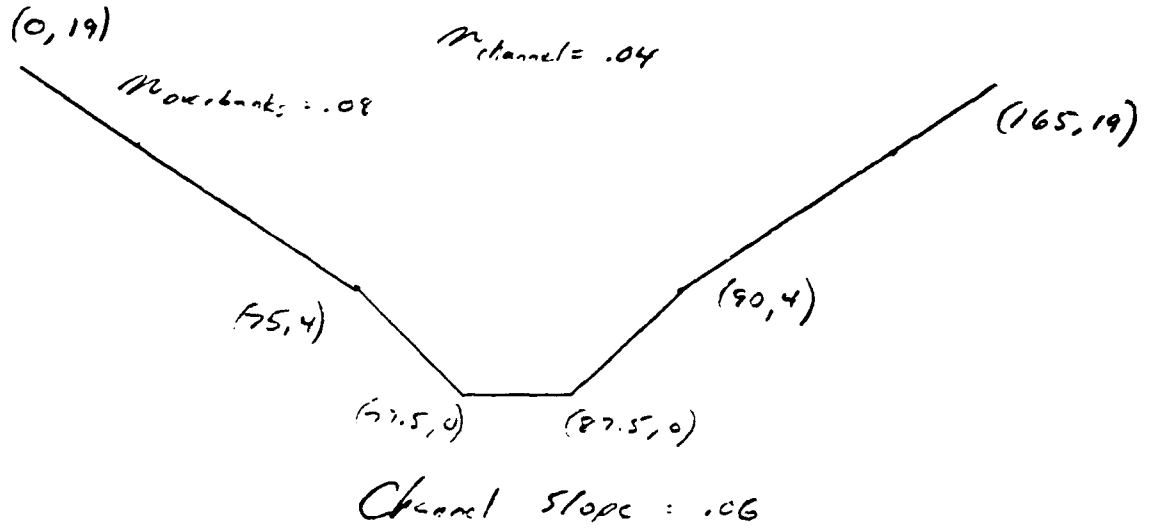
From site plans, width at 1/2 height = 110 feet

$W_b \leq .4\ (110) = 44$ feet

$Q_{pl} = \frac{8}{27} \sqrt{g}\ (44)\ (39)^{1.5} = 18{,}000$ cfs

Peak Failure Outflow = 18,000 + 485 = 18,485 cfs

On the next page is shown a typical cross section for Roaring Brook just downstream of the dam.



The stage-normal flow relationship for this reach is given on the next two pages. A pre-failure flow of 485 cfs would cause a stage of about 2.8 feet in the stream below the dam. At the failure flow of 18,485 cfs, however, the stage would rise to a height of 15.1 feet above the streambed, an increase of 12.3 feet.

Total storage behind the dam above the tailwater level would be 450 + 30 * (2.6) = 528 acre-feet. In the reach between the dam and a road one mile downstream, some attenuation of the failure flow would occur. The calculations for the attenuation are shown following the normal flow table. (Reach Storage = Length x Average Area; Average Area = $\frac{\text{Area Upstream + Area Downstream}}{2}$. The area of the failure wave at the upstream end is 797 sq. ft.).

===== DATA FOR THE COMBINED SYSTEM =====

DEPTH ft.	ELEV ft.	AREA ft↑2	WPER ft.	HYD-R ft.	AR2/3	Q cfs
0.00	0.0	0.0	0.0	0.0	0.0	0.0
0.50	0.5	5.2	11.2	0.5	3.1	28.1
1.00	1.0	10.6	12.4	0.9	9.6	87.7
1.50	1.5	16.4	13.5	1.2	18.6	170.2
2.00	2.0	22.5	14.7	1.5	29.9	272.5
2.50	2.5	28.9	15.9	1.8	43.1	392.9
3.00	3.0	35.6	17.1	2.1	58.2	530.7
3.50	3.5	42.7	18.3	2.3	75.1	685.4
4.00	4.0	50.0	19.4	2.6	93.9	856.6
4.50	4.5	58.8	24.5	2.4	105.2	1083.6
5.00	5.0	70.0	29.6	2.4	124.2	1340.7
5.50	5.5	83.8	34.7	2.4	150.6	1633.1
6.00	6.0	100.0	39.8	2.5	184.7	1965.0
6.50	6.5	118.8	44.9	2.6	227.0	2340.3
7.00	7.0	140.0	50.0	2.8	278.0	2762.4
7.50	7.5	163.8	55.1	3.0	338.4	3234.5
8.00	8.0	190.0	60.2	3.2	408.7	3759.8
8.50	8.5	218.8	65.3	3.3	489.6	4341.2
9.00	9.0	250.0	70.4	3.5	581.8	4981.8
9.50	9.5	283.8	75.5	3.8	685.8	5684.1
10.00	10.0	320.0	80.6	4.0	802.2	6451.1
10.50	10.5	358.8	85.7	4.2	931.7	7285.3
11.00	11.0	400.0	90.8	4.4	1074.8	8189.3
11.50	11.5	443.8	95.9	4.6	1232.1	9165.7
12.00	12.0	490.0	101.0	4.9	1404.1	10216.9
12.50	12.5	538.8	106.1	5.1	1591.4	11345.4
13.00	13.0	590.0	111.2	5.3	1794.6	12553.5
13.50	13.5	643.8	116.3	5.5	2014.2	13843.7
14.00	14.0	700.0	121.4	5.8	2250.7	15218.3
14.50	14.5	758.8	126.5	6.0	2504.6	16679.5
15.00	15.0	820.0	131.6	6.2	2776.5	18229.6

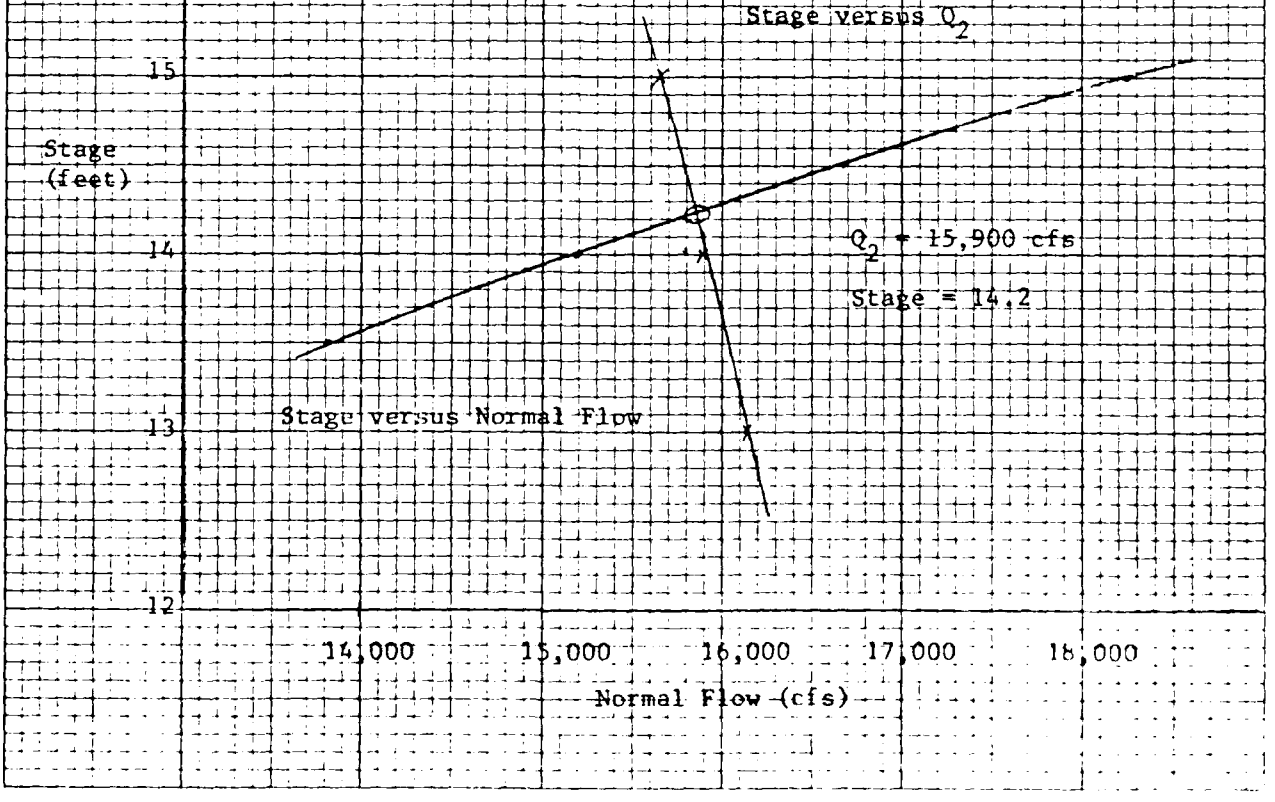
15.50	15.5	883.8	136.7	6.5	3066.8	19870.8
16.00	16.0	950.0	141.8	6.7	3376.0	21605.4
16.50	16.5	1018.8	146.9	6.9	3704.7	23435.4
17.00	17.0	1090.0	152.0	7.2	4053.2	25363.1
17.50	17.5	1163.8	157.1	7.4	4422.2	27390.5
18.00	18.0	1240.0	162.2	7.6	4812.0	29519.7
18.50	18.5	1318.8	167.3	7.9	5223.2	31752.9
19.00	19.0	1400.0	172.4	8.1	5656.1	34092.0

Attenuated Peak Dam Failure Flow One Mile Downstream

$$Q_2 = 485 + Q_{p1}\left(1 - \frac{STOR}{528}\right) = 485 + 18{,}000\left(1 - \frac{STOR}{528}\right)$$

STOR = stream storage increase due to dam failure (acre-feet)

Stage	Area above 3.7 (sq. ft.) $A = 31.4$ ft^2	Area + 588 $\frac{5280}{43560}$ 2	Q_2 (cfs)
14.0	666.6	76.0	15,890
13.0	556.6	69.4	16,120
15.0	786.6	83.3	15,650

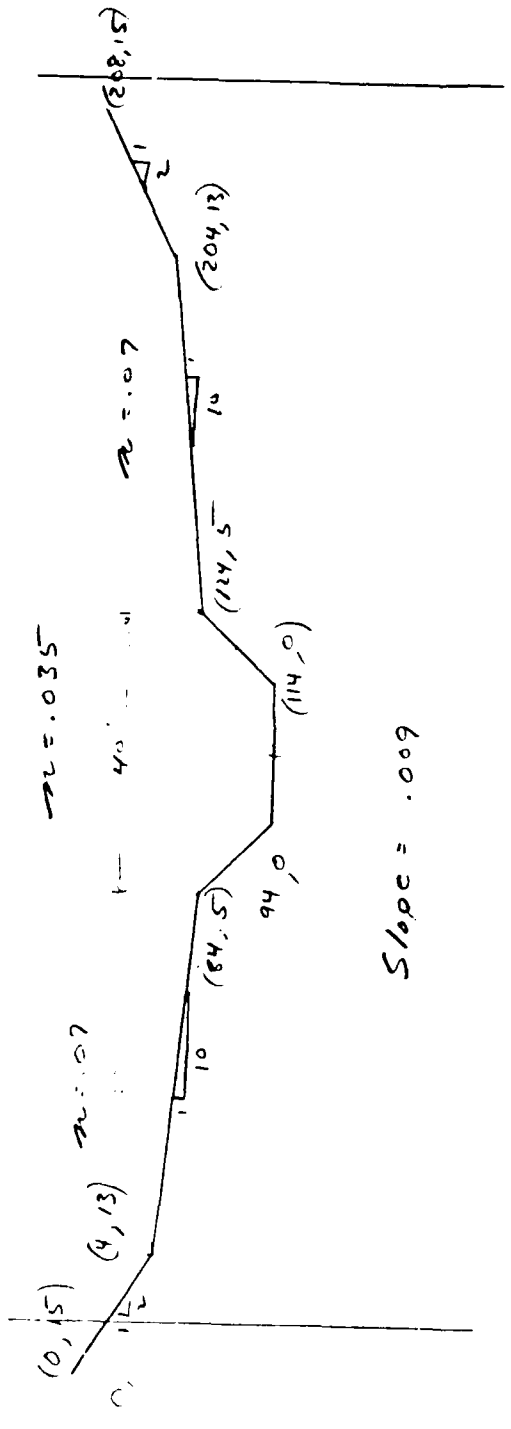


The attenuated dam failure flow at the downstream end of the reach is 15,900 cfs, with a stage of 14.2 feet. Although this stage is rather high, no structures exist within this reach and so no significant damage will be incurred. At the end of this reach, however, Roaring Brook flows through a 16 foot wide by 6 foot high box culvert, with the top of the road only 2 feet above the crown of the culvert.

On the downstream side of the culvert are four houses which are all slightly above the roadway elevation. On the upstream side are two houses; one is about 5 feet above the roadway elevation and the other is about 3 feet above the roadway elevation. It is expected that this area would be severely damaged by the failure flow wave and the threat of loss of life here would be serious. The roadway would also be affected.

Immediately downstream of the road, Roaring Brook enters Otter Brook. Along the banks of Otter Brook are three houses which are about 6 feet above the streambed. A typical cross section and rating curve table for Otter Brook are given on the next pages.

The reach between the confluence of Otter Brook and Roaring Brook and the downstream confluence of Otter Brook and Minnewawa Brook is about 6250 feet. It will be assumed that at pre-failure the stream depth is about 4 feet, with a flow of 930 cfs. Adding the attenuated peak



Typical Cross Section for Otter Brook

===== DATA FOR THE COMBINED SYSTEM =====

DEPTH ft.	ELEV ft.	AREA ft↑2	WPER ft.	HYD-R ft.	AR2/3	Q cfs
0.00	0.0	0.0	0.0	0.0	0.0	0.0
0.50	0.5	10.5	22.2	0.5	6.4	25.7
1.00	1.0	22.0	24.5	0.9	20.5	82.8
1.50	1.5	34.5	26.7	1.3	40.9	165.3
2.00	2.0	48.0	28.9	1.7	67.3	271.6
2.50	2.5	62.5	31.2	2.0	99.4	401.3
3.00	3.0	78.0	33.4	2.3	137.3	554.3
3.50	3.5	94.5	35.7	2.7	181.0	731.0
4.00	4.0	112.0	37.9	3.0	230.7	931.7
4.50	4.5	130.5	40.1	3.3	286.5	1157.0
5.00	5.0	150.0	42.4	3.5	348.5	1407.5
5.50	5.5	172.5	52.4	3.3	381.7	1735.7
6.00	6.0	200.0	62.5	3.2	434.5	2098.2
6.50	6.5	232.5	72.5	3.2	505.6	2498.7
7.00	7.0	270.0	82.6	3.3	594.9	2940.1
7.50	7.5	312.5	92.6	3.4	703.0	3425.3
8.00	8.0	360.0	102.7	3.5	830.9	3956.5
8.50	8.5	412.5	112.7	3.7	979.6	4536.3
9.00	9.0	470.0	122.8	3.8	1150.3	5166.8
9.50	9.5	532.5	132.8	4.0	1343.9	5850.2
10.00	10.0	600.0	142.9	4.2	1561.9	6588.5
10.50	10.5	672.5	152.9	4.1	1805.2	7383.9
11.00	11.0	750.0	163.0	4.6	2075.2	8238.2
11.50	11.5	832.5	173.0	4.8	2372.8	9153.5
12.00	12.0	920.0	183.1	5.0	2699.3	10131.6
12.50	12.5	1012.5	193.1	5.2	3055.8	11174.3
13.00	13.0	1110.0	203.2	5.5	3443.4	12283.6
13.50	13.5	1210.5	205.4	5.9	3949.6	13551.2
14.00	14.0	1312.0	207.6	6.3	4484.3	14882.5
14.50	14.5	1414.5	209.9	6.7	5047.1	16276.4
15.00	15.0	1518.0	212.1	7.2	5637.6	17731.5

dam failure flow gives approximately 16,800 cfs and a stage of about 14.7 feet at the upstream end of this reach. The flow area at the upstream end would be about 1348 square feet (1460 - 112). The attenuation due to stream storage is shown on the next page.

As shown in the calculations, the attenuated peak stage at the end of this reach is 12.9 feet above the streambed. Otter Brook then merges with Minnewawa Brook and the peak stage is further reduced. Although further damage is possible in the area of South Keene, it is expected that the wider channel of Otter Brook would reduce the peak stage enough so that the damage would be minor as compared to the damage potential at the junction of Roaring Brook and Otter Brook.

AD-A156 510 NATIONAL PROGRAM FOR INSPECTION OF NON-FEDERAL DAMS
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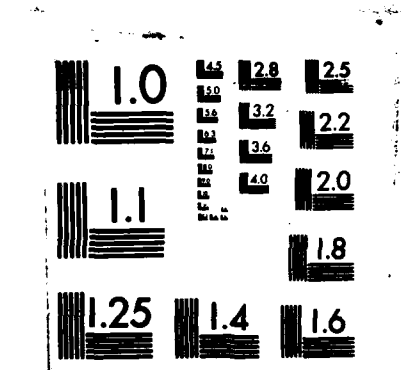
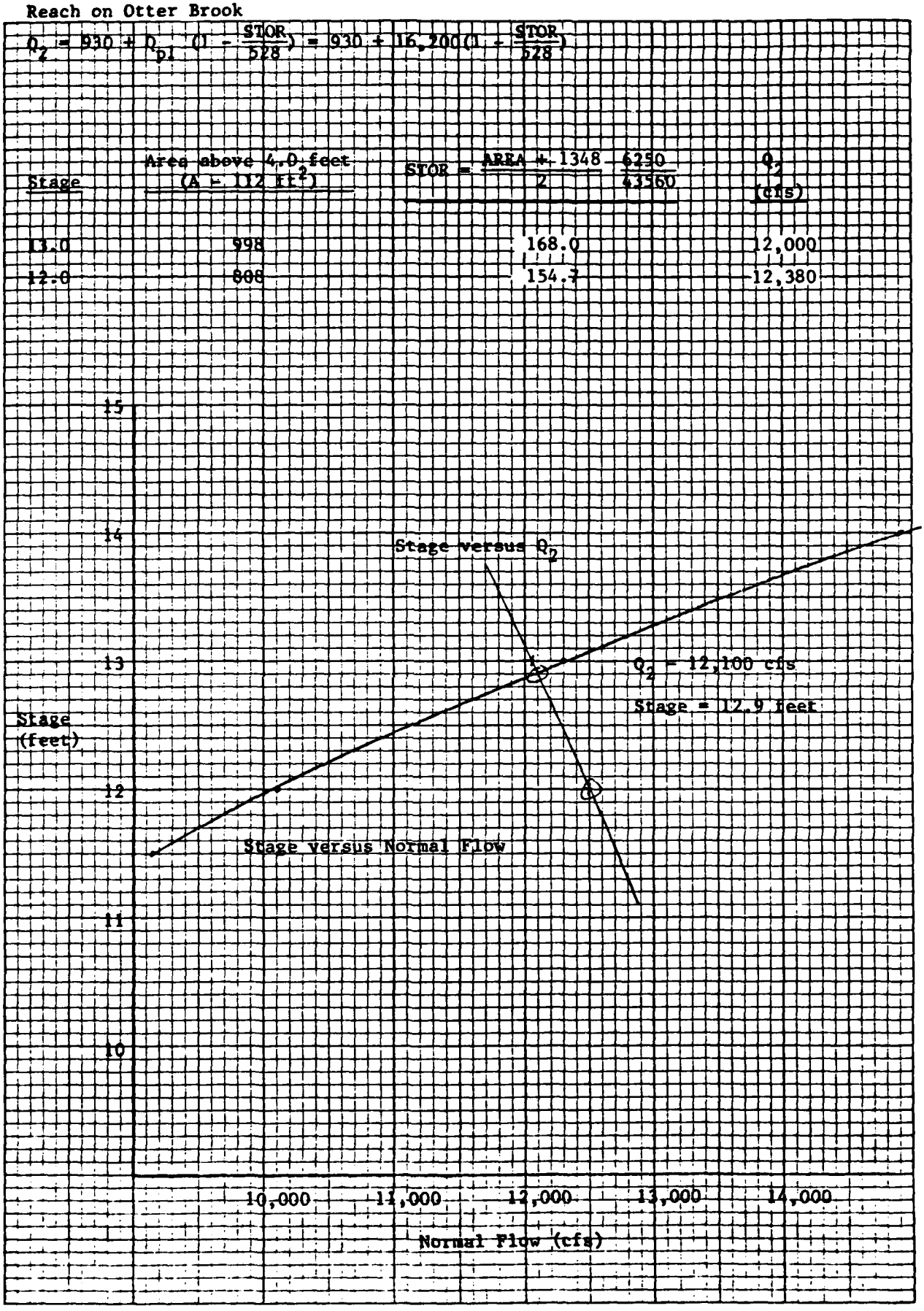

1.0
1.1
1.25
1.4
1.6
1.8
2.0
2.2
2.5
2.8
3.2
3.6
4.0
4.5
5.0
5.6
6.3
7.1
8.0
9.0
MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

Reach on Otter Brook

$$Q_2 = 930 + Q_{p1}\left(1 - \frac{STOR}{528}\right) = 930 + 16,200\left(1 - \frac{STOR}{528}\right)$$

Stage	Area above 4.0 feet ($A - 112$ ft^2)	$STOR = \frac{AREA + 1348}{2} \frac{6250}{43560}$	Q_2 (cfs)
13.0	998	168.0	12,000
12.0	808	154.7	12,380



Test Flood Analysis

Size Classification: SMALL (storage between 50 and 1000 acre-feet; height less than 40 feet)

Hazard Classification: HIGH

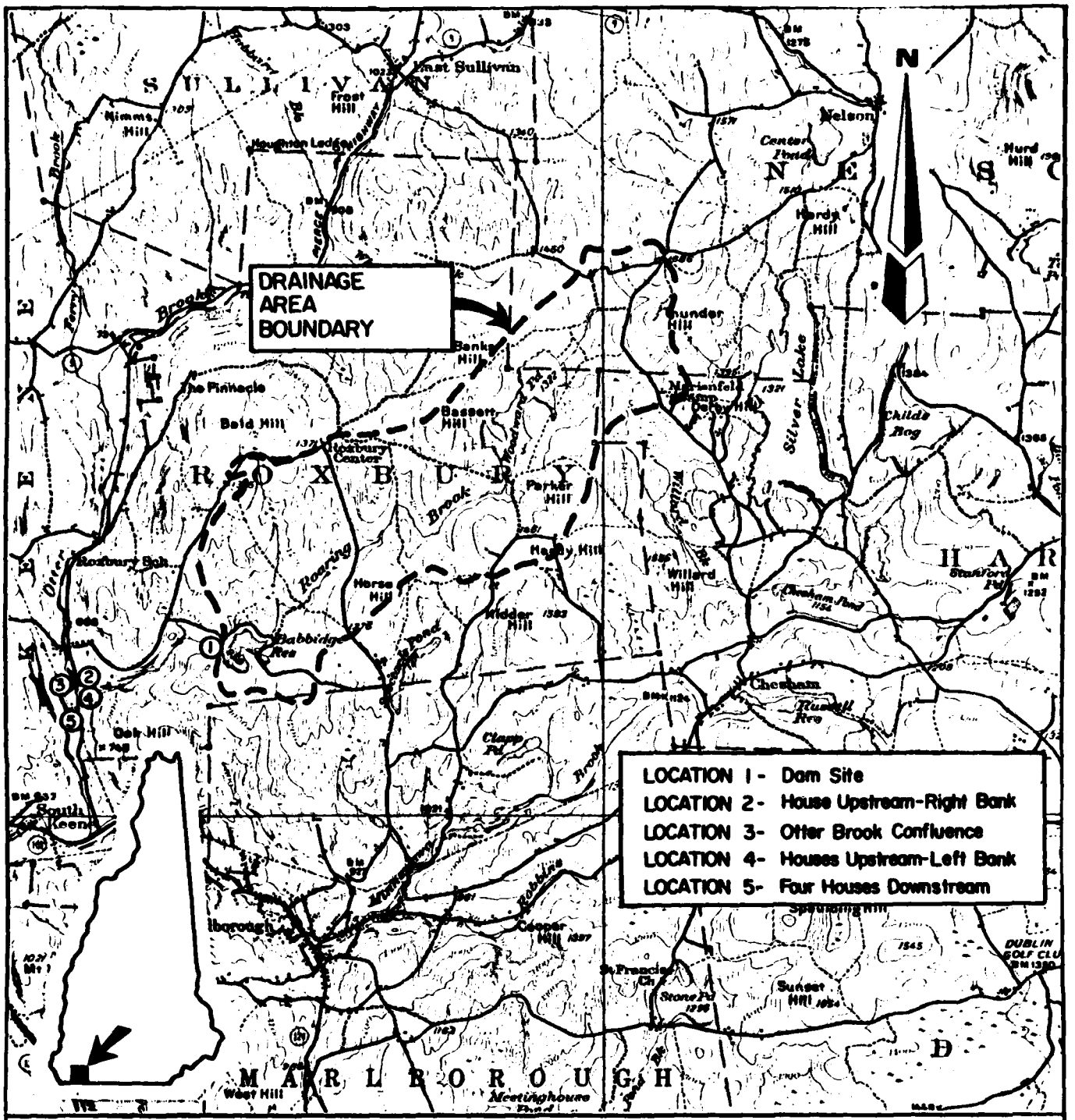
The failure of Babbidge Dam with the water surface at the crest of the dam prior to failure would cause severe damage to some residential houses downstream of the dam. The loss of more than a few lives could be expected. A road about one mile downstream of the dam could be seriously damaged.

The appropriate Test Flood for a dam classified as SMALL in size with a HIGH hazard potential would be between one-half of the Probable Maximum Flood (PMF) and the PMF. Since the hazard potential of the dam is at the lower end of HIGH, one-half the PMF is the appropriate Test Flood.

The terrain of the Babbidge Reservoir dainage area is both rolling and mountainous, and with a drainage area of 5.5 square miles. A PMF discharge rate of 2000 cfs/square mile is appropriate for this type of terrain and drainage area. This results in a PMF inflow of 11,000 cfs. One-half of the PMF is 5,500 cfs.

For a peak test flood inflow of 5,500 cfs, the attenuation due to storage in this small reservoir would be negligible for a flood of this magnitude, so the routed peak test outflow may be said to be

5,500 cfs. The runoff volume would be about 2655 acre-feet as compared to a reservoir surcharge storage-volume of 78 acre-feet to the dam crest (9 in * 295 acre-feet/in = 2655 acre-feet). The peak stage for this event would be about 5.8 feet above the stop log level or 980.2 feet msl. This is 3.2 feet above the dam crest and abutments.



-SCALE-

0 1/2 1 2 (MILES)

FROM: USGS MONADNOCK, NH QUADRANGLE MAP

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NEWTON UPPER FALLS, MASSACHUSETTS

U.S. ARMY ENGINEER DIV. NEW ENGLAND
CORPS OF ENGINEERS
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DOWNSTREAM HAZARD MAP

FILE No. 2805

BABBIDGE RESERVOIR DAM — KEENE, NEW HAMPSHIRE

SCALE AS NOTED

DATE MAY 1981

APPENDIX E

INFORMATION AS CONTAINED IN THE NATIONAL INVENTORY OF DAMS

NOT AVAILABLE AT THIS TIME

END

DATE
FILMED

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